REPORT

ON THE

BRITISH FOSSIL MAMMALIA.

BY

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Report on the British Fossil Mammalia.

By Richard Owen, *Esq.*, *F.R.S.*

Part II. *Ungulata.*

Order Pachydermata.

Genus *Elephas.*

When the science of fossil organic remains was less advanced than it is at present, when its facts and generalizations were new, and sounded strange not only to the ears of the unscientific but to anatomists and naturalists, the announcement of the former existence of animals in countries where the like had not been known within the memory of man, still more of species not known to exist in any part of the world, was received with distrust and doubt, and many endeavours were made to explain the former phænomena by reference to known circumstances that might have led to the introduction of tropical animals into temperate zones within the historical period. When Cuvier first announced the existence of Elephants, Rhinoceroses and Hippopotamuses in the superficial unstratified deposits of continental Europe, he was reminded of the Elephants that were introduced into Italy by Pyrrhus in the Roman wars, and afterwards more abundantly, and with the stranger quadrupeds of conquered tropical countries, in the Roman triumphs and games of the amphitheatre Cuvier's minute anatomical distinctions, proving the disinterred fossils to have belonged to extinct species of *Elephas*, *Hippopotamus*, *Rhinoceros*, &c., were at first hardly appreciated, and, by some of his contemporaries, were explained away or dissallowed. Cuvier, therefore, appealed with peculiar satisfaction to the testimonies and records of analogous Mammalian fossils in the British Isles, to the origin of which it was obvious that the hypothesis of Roman or other foreign introduction within the historical period could not be made applicable.

"If," says the founder of palæontological science, "passing across the German Ocean, we transport ourselves into Britain, which, in ancient history, by its position, could not have received many living elephants besides that one which Cæsar brought thither according to Polinæus*; we shall, nevertheless, find there fossils in as great abundance as on the continent."

Cuvier then cites the account given by Sir Hans Sloane of an elephant's fossil tusk, disinterred in Gray's Inn Lane, out of the gravel twelve feet below the surface. Sir Hans Sloane had obtained also the molars of an elephant from the county of Northampton, which were found in blue clay beneath vegetable mould and loam, from 3 to 6 feet below the surface; these specimens were explained by Dr. Cüper as having belonged to the identical elephant brought over to England by Cæsar; but Cuvier remarks that too many similar fossils had been found in England to render that conjecture admissible. He then proceeds to quote the instances recorded at the period of the publication of the 'Ossemens Fossiles.'

Dr. Buckland adds the weighty objection, that the remains of these Elephants are usually accompanied in England, as on the continent, by the bones of the Rhinoceros and Hippopotamus, animals which could never have been attached to Roman armies; and I may add, that the natural historians of Ireland, Neville and Molineux, made known in 1715 the existence of fossil molar teeth of the Elephant at Maghery, eight miles from Belturbet in the county of Cavan, and similar evidences of the Elephant have since been discovered in other localities of Ireland, where the armies of Cæsar never set foot. Some other hypothesis must therefore be resorted to in order to explain these phænomena.

* Lib. viii. c. 23. § 5. cited in Ossem. Fossiles, 4to, 1821, tom. i. p. 134.

Observation, which ought to precede all hypothesis, as it alone can form the basis of any sound one, has shown in the first place that the remains of the Elephants which are scattered over Europe in the unstratified superficial deposits called 'Diluvium,' 'Drift,' 'Till,' 'Glacio-diluvium,' as well as those from the upper tertiary strata, are specifically different from the teeth and bones of the two known existing Elephants, the *Elephas Indicus* and *El. Africanus*. This fundamental fact, when first appreciated by Cuvier, who announced it in 1796, opened to him, he says, entirely new views of the theory of the earth, and a rapid glance, guided by the new and pregnant idea, over other fossil bones, made him anticipate all that he afterwards proved, and determined him to consecrate to this great work the future years of his life.

The differences which the skull of the fossil Elephant presents as compared with the recent species are, the more angular form and relative shortness of the zygomatic processes; the longer, more pointed and more curved form of the postorbital process; the larger and more prominent tubercle of the lachrymal bone; the greater length of the sockets of the tusks; the more parallel position of the right and left sockets of the grinders, making the anterior interspace and channel at the junction of the rami of the lower jaw proportionably wider than in the existing Elephants. Of the differences in the conformation of the skull above enumerated, I have verified the last-mentioned instance, taken from the lower jaw, by observation of English specimens; they are well displayed in the lower jaw of a young Mammoth disinterred from a Pleistocene bed near Yarmouth in the county of Norfolk, and now in the possession of Mr. E. Stone, of Garlick Hill, London.

This lower jaw shows also that the outer contour of one ramus meets that of the other at a more open angle than in the African or Asiatic Elephant, and that the symphysis itself, though acute at this period of life, is less prolonged. In the older Mammoths the symphysis becomes obtuse; were it otherwise, the prolonged alveoli of the fully-developed tusks would have interfered with the motion of the lower jaw.

The difference between the extinct and existing species of Elephant in regard to the structure of the teeth, has been more or less manifested by every specimen of fossil elephant's tooth that I have hitherto seen from British strata, and those now amount to upwards of three thousand. Very few of them could be mistaken by a comparative anatomist for the tooth of an Asiatic Elephant, and they are all obviously distinct from the peculiar molars of the African Elephant.

Cuvier, who had recognized a certain range of variety in the structure of the numerous teeth of the Mammoth from continental localities, found nevertheless that the molars of the fossil Elephant were broader in proportion to their length or antero-posterior diameter than in the existing species; that the transverse plates were thinner and more numerous in the fossil molars than in those of the Indian Elephant; that a greater number of plates entered into the formation of the grinding surface of the tooth, and that the lines of enamel were less festooned; but to this character there are exceptions, especially in the large molars of aged individuals.

Varieties.—Question of Species.

The varieties to which the grinders of the different species of Elephants are subject in regard to the thickness and number of their plates, increase in the ratio of the average number of the plates which characterizes the molar teeth of the different species. Thus in the African Elephant, in which the lozenge-shaped plates are always much fewer and thicker than the flattened

ones in the Indian species, the variation which can be detected in any number of the grinders of the same size is very slight.

In the Asiatic Elephant, which, besides the difference in the shape of the plates, has always thinner and more numerous plates than the African one, a greater amount of variation in both these characters obtains; but it is always necessary to bear in mind the caution which Cuvier suggested to Camper, that a large molar of an old elephant is not to be compared with a small molar of a young one, otherwise there will appear to be a much greater discrepancy in the thickness of the plates than really exists in the species; and the like caution is still more requisite in the comparison of the molars of the Mammoth or fossil Elephant (*Elephas primigenius*), which, having normally more numerous and thinner plates than in the existing Asiatic Elephant, present a much greater range of variety.

Of the extent of this variety in the British fossils some idea may be gained by the fact, that in one private collection, that of Miss Gurney of Cromer, of fossil Mammalian remains from a restricted locality, there are Mammoth's teeth from the drift of the adjacent coast, one of which, measuring 10 inches 9 lines in antero-posterior diameter, has nineteen plates, whilst another grinder, 11 inches in antero-posterior diameter, has only thirteen plates.

A greater contrast is presented by two grinders of the Mammoth from British diluvium in the collection of the late Mr. Parkinson, one of which, with a grinding surface of $5\frac{1}{2}$ inches in antero-posterior extent, exhibits the abraded summits of seventeen plates, whilst the other shows only nine plates in the same extent of grinding surface.

Some palæontologists have viewed these differences as indications of distinct species of *Elephas*. But the vast number of grinders of the Mammoth from British strata which have been in my hands in the course of the last three years have presented so many intermediate gradations, in the number of plates, between the two extremes above cited, that I have not been able to draw a well-defined line between the thick-plated and the thin-plated varieties of the molar teeth. And if these actually belonged to distinct species of Mammoth, they must have merged into one another, so far as the character of the grinding teeth is concerned, in a degree to which the two existing species of Elephant, the Indian and African, when compared together, offer no analogy.

Five or six molars of the Mammoth, and even a greater number, if the peculiar changes superinduced by friction on the grinding surface were not taken into account, might be selected from such a series as I have above referred to, as indications of as many distinct species of Mammoth: such specimens have been so interpreted by Parkinson, and likewise by Fischer, Goldfuss, Nesti and Croizet, cited in the *Palæologica* of Hermann V. Meyer, as authorities for eight distinct species of extinct Elephant.

We must, however, enter more deeply into the consideration of these varieties, before concluding that the Mammoths which severally exemplify them in their molar teeth were distinct species. In the first place, whatever difference the molars of the Mammoth from British strata have presented in the number of their lamellar divisions, they have corresponded in having a greater proportion of these plates on the triturating surface, and likewise, with two exceptions, in their greater proportional breadth, than the molars of the Asiatic Elephant present. The first exception here alluded to was from the diluvial gravel of Staffordshire, and formed part of the collection of Mr. Parkinson, the author of the 'Organic Remains;' the second exception was from the brick-earth of Essex, and is now in the collection of my friend Mr. Brown of Stanway; this molar, though it combines the thicker plates with the narrower form of the entire tooth characteristic of the Indian Elephant, differs

in the greater extent of the grinding surface and the greater number of plates entering into the composition of that surface.

With regard to the first-cited exception, the following is the result of a close comparison instituted between it and a corresponding grinder of the Indian Elephant.

The fossil in question is an inferior molar of the right side of the lower jaw. It exhibits the most complete state in which so large a grinder can be met with, the anterior division of the crown not being quite worn down to the fang, and the hindmost plate being just on the point of coming into use. The whole length of the tooth is 13 inches; the total number of lamellar divisions of the crown seventeen, of which the summits of fourteen are abraded in a grinding surface of 9 inches' extent. The greatest breadth of this surface is $2\frac{1}{2}$ inches. The first three fangs supporting the common dentinal base of the anterior lamellæ are well developed. The transverse ridges of enamel are festooned. Compared with the thin-plated grinders of the Mammoth, these differ not only in their more numerous, thinner and broader plates, but likewise in the thicker coat of external cement which fills the lateral interspaces of the coronal plates, and in having the fangs developed from the whole base of the tooth, even from the posterior plate, the summit of the mammillary process of which has just begun to be abraded. But from the corresponding molar of the Indian Elephant the present tooth of the Mammoth differs in the more equable length of the coronal plates, which in the Elephant, by their more progressive elongation, give a triangular figure to the side-view of the crown; it differs also in the greater length of the grinding surface, which includes two additional plates, although these are not thinner and are not characterized by superior breadth as in the ordinary teeth of the Mammoth.

These differences from the teeth of the Indian Elephant, and the intermediate gradations in the fossil molars by which such rare extreme varieties are linked to the normal type of the Mammoth's dentition, justify us in rejecting the conclusion that the *Elephas Indicus* coexisted with the Mammoth in the latitude of England during the antediluvial or anteglacial epoch: and I think it probable that such differences as have been pointed out in the molar from the Museum of Parkinson, and that of the existing Elephant, might likewise have been detected in the large molar, found at the depth of 6 feet, in brick loam, at Hove near Brighton, and alluded to by Dr. Mantell as decidedly that of the Asiatic Elephant *. One of the molars from the Elephant bed at Brighton, now in the possession of Mr. Stone of Garlick Hill, exhibits the narrow-plated variety of the Mammoth's grinder. The molars of the Mammoth generally contain a greater proportion of cement in the intervals of the plates than the Indian Elephant's grinders do. Those in which the plates are more numerous have the enamel less strongly plicated; but in some of the large molar teeth of old Mammoths with the thicker plates, I have seen the enamel as strongly festooned as in the teeth of the Indian Elephant.

The bones of the Mammoth that have hitherto been disinterred present no variations from the characteristic extinct type indicative of distinct species; and it might reasonably have been expected that the lower jaw, for example, with the broad-plated tooth should offer as recognizable differences from that with the narrow-plated teeth, as this does from the lower jaw of the Indian Elephant, if those modifications of the teeth of the Mammoth indicated distinct species. The lower jaw, however, of the ancient British Mammoth has the same distinctive modification of the symphysis as that of the typical Siberian

* Fossils of the South Downs, 4to, 1822, p. 283.

specimen figured by Cuvier, and which is equally presented by that of the Mammoth of Auvergne, figured by the Abbé Croizet *, and by that described by Nesti †.

Both these authors being unacquainted with the intermediate varieties, incline to regard the Mammoth with the thick-plated molars as a distinct species, which V. Meyer in his work cites as the *Elephas meridionalis*. In regard, however, to the proposed distinctive name, I may remark that the variety of molar on which this species is founded occurs not only in England, but in Siberia, and as far north as Eschscholtz Bay.

Most of the molars of the Mammoth from North America are characterized by thinner and more numerous plates than those of England, but the difference is not constant. The Mammoth's molar from the Norfolk coast in the collection of Miss Gurney, which shows nineteen plates in a length of 10 inches, equals several of the molars from North America in the number of the plates. An upper molar of a Mammoth from the gravel of Ballingdon, with a total antero-posterior diameter of 7 inches, consists of twenty plates. Mr. Parkinson cites a molar, now in the Museum of the College of Surgeons, from Wellsbourne in Warwickshire, in which twenty plates exist in a length of $6\frac{1}{2}$ inches; and he figures another molar from the till of Essex, which, in a length of $8\frac{1}{2}$ inches, contains twenty-four plates. On the other hand, the molars of the Mammoths from Eschscholtz Bay, North America, figured by Dr. Buckland, manifest the same kind of variety as those from the English drift; one with a grinding surface $7\frac{1}{2}$ inches long, exhibiting nineteen plates, whilst another in the same extent of grinding surface shows only thirteen plates; both these teeth are from lower jaws, which, like the lower jaw containing the broader-plated tooth described by Prof. Nesti, are precisely similar in form to the other fossil jaws of the Mammoth; they present the same specific differences from the Asiatic Elephant, and offer no modification that can be regarded as specifically distinct from the Mammoth's jaws with narrow-plated molars of Siberia or Ohio.

Mr. Parkinson has figured a Mammoth's molar from Staffordshire, which he deemed to differ from every other that had come to his knowledge in the great thickness of the plates, the smoothness of the sides of the line of enamel, and the appearance of the digitated part of the plates even in the anterior part of the tooth ‡.

This specimen, which is now in the Museum of the College of Surgeons, is the posterior part of a large grinder of an old Mammoth. The superior thickness of the plates arises from the circumstance of the posterior plates being thicker than the anterior ones; these thick plates are more deeply cleft, or their digitated summits are longer, and advance further forward upon the grinding surface of the molar before they are worn down to their common base; they appear also in the specimen to be more advanced than they really are, because of the deficiency of the fore-part of the tooth, which has been broken away. In my opinion this molar has the characters of the thick-plated variety, simply exaggerated from the accidents of age and mutilation above-mentioned. It manifests the more constant and characteristic modifications of the *Elephas primigenius* in its relative breadth, and, notwithstanding their thickness, in the number of the plates (nine), which have been exposed by attrition. I have seen a very similar molar of the Mammoth from the Norfolk freshwater deposits in the collection of Mr. Fitch of Norwich.

The abraded summits of the component plates of the Mammoth's molars most commonly present a slight expansion, often lozenge-shaped, at their

* Fossiles du Puy-de-Dome, p. 125. pl. 3. fig. 1.

† Nuov. Giorn. d. Letter. 1825, p. 195.

‡ Organic Remains, iii. p. 344.

centre; the summits of the plates are originally divided, with more regularity, in general, than those in the Indian Elephant, into three digital processes, the middle being usually the broadest and thickest; this character is shown by the middle dilatation when the three digitations are worn down to their common base. Only in one small molar, from the brick-earth at Grays, Essex, in the collection of Mr. Wickham Flower, have I seen the median rhomboidal dilatation, extending, in the abraded plates, so near the end of the section as to approximate the characteristic shape of the plates of the African Elephant's molar; from which, however, the fossil was far removed by its thinner and more numerous plates. The fictitious character of the *Elephas priscus* of Goldfuss and of V. Baer, one of the eight fossil species admitted in the compilation of V. Meyer, has been demonstrated by Cuvier. I have met with no nearer approach to this nominal species among the numerous British Mammoth's grinders that I have examined, than the example just quoted from Grays; I need hardly say that I regard it as another of the numerous varieties to which the molars of the Mammoth were subject.

The clefts that separate the transverse plates are deeper at the sides than at the middle of the tooth in all Mammoths' grinders; hence the ridges of enamel in a much-worn molar are confined to the outer and inner sides of the grinding surface, which is traversed along the middle by a continuous tract of dentine. The layer of enamel extends to this exposed tract, is reflected back upon the opposite side of the lateral cleft, bends round the outer margin of the remaining base of the plate, and is continued into the next fissure, and so on. When the edge of this sinuous coat of enamel is exposed by friction, it describes what Mr. Parkinson has called a "Dædalian line," and he has figured two examples of teeth so worn down in the 'Organic Remains*.' Having noticed the structure in three specimens, Mr. Parkinson conceives it to be characteristic of a distinct species of Mammoth. But the ordinary teeth of the Mammoth, from the unequal vertical extent of their plates above described, must necessarily produce the continuous undulating lateral lines of enamel when worn down to a certain extent. I have seen it only in a few amongst the numerous molars of the Mammoth examined by me, for teeth so worn down are rare. It is well shown in the remains of a very large molar, found in the beach near Happisburg, Norfolk, which on a grinding surface of 4 inches 9 lines in length and 4 inches wide, shows seven dentinal plates worn down to their common uniting base of dentine, along the middle of the surface.

It sometimes happens that the outer and inner margins of a plate, which are always deeper than the middle part, are not on the same transverse line, but one is inclined a little in advance of the other. In this case the abraded crown of the tooth, when worn down to the common middle base of dentine, displays an alternating disposition of the folds of the outer and inner sinuous lines of enamel. This variety affords grounds of the same kind and value for a distinct species of Mammoth as for the two other new species proposed by Mr. Parkinson.

A consideration of the anatomical structure and an extensive comparison of the teeth in question have led me to the conclusion, that whilst some of the supposed specific characters are due to effects of changes produced by age, the others are due to the latitude of variety to which the highly complex molars of the *Elephas primigenius* were subject.

In proof of such variety we have the analogy of existing species: that such variety is the characteristic of a particular part of the enduring remains of the Mammoth, may be inferred from the absence of any corresponding dif-

* Pl. 20. figs. 5 and 7.

ferences in the bones of the Mammoth that have hitherto been found; all of which indicate but one species. And this conclusion harmonizes with the laws of the geographical distribution of the existing species of Elephant.

Throughout the whole continent of Africa but one species of Elephant has been recognized. A second species of Elephant is spread over the south of Asia and some of the adjacent islands; and the results of the more extensive and accurate observations of this species, whilst they make known some well-marked varieties, as the Mooknah, the Dauntelah, &c., founded on modifications of the teeth, establish the unity of species to which those varieties belong. If the observed varieties in the dentition of the Mammoth are to be interpreted, as Parkinson, Nesti, Croizet, V. Meyer and others have done, as evidences of distinct species, we must be prepared to admit not merely three, but six or more distinct species of gigantic Mammoths to have roamed through the primeval swamps and forests of England.

Tusks.—The complete or nearly complete tusks of the *Elephas primigenius* from British strata which have fallen under my observation, possess the same extensive double curvature as the tusks of the great Mammoth in the museum of St. Petersburgh, from the icy cliff at the mouth of the Lena in Siberia, and as those brought to England by Capt. Beechey from Eschscholtz Bay, which have been figured by Dr. Buckland, and are now in the British Museum.

A very perfect specimen, but of moderate size, was lately dug up twelve feet below the surface out of the drift gravel of Cambridge; it measures 5 feet in length and 2 feet 4 inches across the chord of its curve, and it is 11 inches in circumference at the thickest part of its base.

In the collection of Mr. Brown of Stanway there is a fragment of a tusk of the Mammoth, from the freshwater formation at Clacton in Essex, which measures 2 feet in circumference, thus exceeding the size of the largest of the tusks brought home by Capt. Beechey from Eschscholtz Bay.

A very fine tusk of the Mammoth from British strata forms part of the remarkable collection of remains of the Mammoth obtained by the Rev. J. Layton from the drift of the Norfolk coast, near the village of Happisburgh; it was dredged up in 1826, measured 9 feet 6 inches in length, and weighed ninety-seven pounds.

At Knole-sand, near Axminster, about twenty miles from the coast, Sir H. De la Beche obtained a tusk 9 feet 8 inches in length. The finest tusk of a British Mammoth forms part of the rich collection of fossil Mammalian remains obtained from Ilford by the late Joseph Gibson, Esq. of Stratford, Essex; this tusk measured 12 feet 6 inches in length, following the outward curvature.

The smallest Mammoth's tusk which I have seen is in the museum of Mr. Wickham Flower; it is from the drift or till at Ilford, Essex, and has belonged to a very young Mammoth; its length measured along the outer curve is $12\frac{1}{2}$ inches, and the circumference of its base is 4 inches. It has nevertheless been evidently put to use by the young animal, the tip having been obliquely worn.

The small tusk from the Cambridge gravel has not belonged to a young animal, but is fully formed, and it most probably indicates a sexual character, analogous to that in the existing Indian Elephant; the tusks in the female Mammoth, although more developed than they are in the female *Elephas Indicus*, yet being much shorter than in the male Mammoth.

Bones.—Of the bones of the trunk and extremities of the Mammoth, a few examples may be briefly noticed. Of two specimens of the atlas of the Mam-

moth from the newer Pliocene near Cromer, in the collection of Miss Gurney, the most perfect measures

	In.	Lines.
In breadth	16	6
Breadth of the anterior condyles	7	10
Breadth of the posterior ditto	9	8
In vertical diameter	10	0

A vertebra dentata from the freshwater deposits at Clacton, Essex, twenty feet above high water mark, in the collection of Mr. Brown of Stanway, measures 6 inches 9 lines in transverse diameter, 5 inches in vertical diameter, and has a spinal canal 3 inches in transverse diameter.

A dorsal vertebra, in the same collection, measures in height 1 foot 10 inches, the spinous process being 9 inches high. The transverse diameter of the vertebra is 8 inches 6 lines, that of the spinal canal being 3 inches.

In Mr. Brown's collection is also preserved the os sacrum of a Mammoth from the freshwater formations of Essex. It is of a triangular form; the transverse diameter of the forepart of the body of the first sacral vertebra is 6 inches 6 lines; the diameter of the largest nervous foramen was 2 inches 4 lines.

A scapula, with the spine, the supra-spinal plate and base broken away, from the same formation, shows the characteristic superior breadth of the glenoid articular cavity at its inferior part, and the shortness of the neck of the scapula, which Cuvier has recognized in the scapula of the Siberian Mammoth.

This scapula gave the following dimensions:—

	Ft.	In.
From the glenoid cavity to the inferior angle	1	10
From ditto to the spine	0	4
From the middle of the spine to the lower costa of the scapula	0	8

In a fragment of a Mammoth's scapula from Happisburgh, in the collection of Mr. Fitch of Norwich, the long diameter of the glenoid articulation was 10 inches, its short diameter 4½ inches. The head of the humerus, in the state of an epiphysis, found with the above fragment, measures 10½ inches in its longest diameter. These parts, notwithstanding their dimensions, have belonged to an immature specimen of the Mammoth.

Of the stupendous magnitude to which some individuals, doubtless the old males, of the *Elephas primigenius* arrived, several fossils from the British drift afford striking evidence.

In the noble skeleton of the Mammoth now at St. Petersburgh, which was found entire in the frozen soil of the banks of the Lena, the humerus is 3 feet 4 inches in length; that of the skeleton of the large Indian Elephant (Chuny) which was killed at Exeter Change in 1826, is 2 feet 11 inches in length. In the rich collection of Mammalian remains from the Norfolk coast, belonging to Miss Gurney of North-repps Cottage, near Cromer, there is an entire humerus of the Mammoth which measures 4 feet 5 inches in length.

Subjoined are a few of the dimensions of this enormous bone and of its analogue in the above-mentioned skeleton of the Indian Elephant in the Museum of the College of Surgeons:—

	El. primigenius.			*El. Indicus.*		
	Ft.	In.	Lin.	Ft.	In.	Lin.
Humerus, entire length	4	5	0	2	11	0
Circumference at the middle	2	2	6	1	1	6
Ditto at proximal end	3	5	0	2	8	0
Breadth of distal end	1	2	0	0	10	6
From summit of supinator ridge to end of outer condyle	1	7	0	1	0	6

The humerus of the Mammoth was found in 1836, after a very high tide, partially exposed in the cliff, composed of interblended blue clay and red gravel, near the village of Bacton in Norfolk. The outer crust of the bone is much shattered; it manifests the specific distinction of the humerus of the Mammoth in the relatively shorter proportions of the great supinator ridge, as is shown by the last admeasurement, and the bicipital canal is also relatively narrower.

A portion of a large tibia was obtained from the same bed in 1841; this bone likewise is in Miss Gurney's collection.

A humerus of the Mammoth, wanting the proximal end, from Clacton, Essex, in the collection of Mr. Brown of Stanway, measures 2 feet 10 inches in length, and 15 inches 6 lines in median circumference, showing the thicker proportions as compared with the existing Elephant.

The bones of the fore-arm of the Mammoth from British localities have not offered any characters worthy of notice.

Of those of the fore-foot I have examined some magnificent specimens obtained by Mr. Ball from the brick-loam near Grays, Essex, and which have belonged to a Mammoth as large as that which must have furnished the humerus above described.

The following are the comparative dimensions of some of those bones and of their analogues in the skeleton of Chuny, the great Asiatic Elephant of Exeter Change:—

	El. primigenius.		*El. Asiaticus.*	
	In.	Lin.	In.	Lin.
Os magnum, vertical diameter	4	3	3	0
Middle metacarpal, length	10	0	7	0
Middle breadth of distal end	4	9	3	4

Mr. J. Wickham Flower possesses a fine and perfect specimen of the femur of the Mammoth from the Essex till, which offers the usual characteristic of the extinct species in the relatively narrower posterior interspace between the two condyles and in the thicker shaft. The outer ridge of the femur extends about two-thirds down the bone. The following are some of its dimensions compared with that of the Indian Elephant:—

	El. primigenius.			*El. Indicus.*		
	Ft.	In.	Lin.	Ft.	In.	Lin.
Length	3	4	0	3	6	0
Breadth across proximal end	1	1	6	1	1	0
Breadth across back part of condyles	0	7	6	0	7	0
Circumference of shaft	1	2	6	1	0	0

A femur of the Mammoth, from the drift gravel at Abingdon, is preserved in the Ashmolean Museum. It is remarkable for its fine state of preservation, and exhibits the same character of the extinct species as the foregoing specimen.

The femur of the Mammoth, described by the notable French Surgeon Habicot, in his 'Gigantosteologie, 1613,' as the thigh-bone of Theutobochus, king of the Cimbrians, which was said to be 5 feet in length, indicates a specimen larger than that to which the humerus from Cromer belonged. M. de Blainville is, however, of opinion that the femur in question belonged to a Mastodon.

Strata and Localities.—Of all the extinct Mammalia which have left their fossil remains in British strata, no species was more abundant or more widely distributed than the Mammoth or *Elephas primigenius.*

Wherever the last general geological force has left traces of its operations upon the present surface, in the form of drift or unstratified transported frag-

ments of rock and gravel, and wherever the contemporary or immediately antecedent more tranquil and gradual operations of the sea or fresh waters have formed beds of marl, of brick-earth or loam, there, with few exceptions, have fossil bones or teeth of the Mammoth been discovered.

It would be tedious to specify all the particular localities from which, in collecting the materials for the present report, I have entered records of the existence of the fossil remains of this gigantic quadruped. They are most remarkable for their abundance in the drift along the east coast of England, as at Robin Hood's Bay near Whitby; at Scarborough, at Bridlington, and various places along the shore of Holderness.

Mr. Woodward, in his 'Geology of Norfolk,' supposes that upwards of two thousand grinders of the Mammoth have been dredged up by the fishermen off the little village of Happisburgh in the space of thirteen years. The oyster-bed was discovered here in 1820, and during the first twelve months hundreds of the molar teeth of Mammoths were dredged up. Great quantities of the bones and tusks of the Mammoth are doubtless annually destroyed by the action of the waves of the sea. Remains of the Mammoth are hardly less numerous in Suffolk, especially in the pleistocene beds along the coast and at Stutton; they become more rare in the fluvio-marine crag at Southwold and Thorp. The village of Walton near Harwich is famous for the abundance of these fossils, which lie along the base of the sea-cliffs, mixed with bones of species of Horse, Ox and Deer.

Reference has already been made to other localities in Essex, as Clacton, Grays, Ilford, Copford and Kingsland, where, in the freshwater deposits, the remains of the extinct Elephant occur, associated with the above-mentioned Herbivora, and with more scanty remains of Rhinoceros.

In the valley of the Thames they have been discovered at Sheppey, Woolwich, the Isle of Dogs, Lewisham; in the drift gravel beneath the streets of the metropolis, as in Gray's Inn Lane, twelve feet deep; in Charles Street, near Waterloo Place, thirty feet deep.

Passing westward we encounter Mammoths' remains at Kensington, at Brentford, at Kew, and at Hurley-bottom, Wallingford near Dorchester; in the gravel-pits at Abingdon and Oxford, and at Witham Hill and Bagley Wood*. Bones of the great extinct Elephant again occur in the valley of the Medway, at the Nore, at Chatham, and at Canterbury. On the south coast of England they have been discovered at Brighton, Hove and Worthing; at Lyme Regis and Charmouth; also at Peppering near Arundel, about 80 feet above the present level of the Arun. Passing inland from the south coast we find remains of the Mammoth at Burton and Loders, near Bridport, and near Yeovil in Somerset. At Whitchurch, near Dorchester, Dr. Buckland observes that the remains of the Mammoth lie in gravel above the chalk, and are found in a similar position on Salisbury Plain; they again occur at Box and Newton near Bath, and at Rodborough in Gloucestershire.

Mr. Randall of Stroud has lately acquainted me, that in some recent railway excavations in the neighbourhood of that town, tusks and molar teeth of a Mammoth have been discovered in drift gravel from fourteen to twenty feet below the surface: one of the tusks was recovered in a tolerably perfect state, and measured 9 feet in length; it is in the possession of — Carpenter, Esq., of Gannicox House, near Stroud.

In Worcestershire, on the borders of the Principality, remains of the Mammoth are noticed by Mr. Murchison as occurring in a gravel-pit south of Eastnor Castle. This pit is in the midst of a group of Silurian rocks, and the frag-

* Dr. Kidd's Geological Essays.

ments consist exclusively of those rocks and of the sienite of the adjacent hills, whence Mr. Murchison rightly infers that this extinct species of Elephant formerly ranged over that country. In North Wales Pennant mentions two molar teeth and a tusk found at Holkur, near the mouth of the Vale of Clwyd, in Flintshire, and near Dyserth ; they occurred in a bed of drift gravel containing pebbles of lead-ore, which are worked like the analogous stream-works which contain pebbles and sand of tin-ore in Cornwall.

Bones of the Mammoth, with those of the Rhinoceros and Hippopotamus, have been found in coarse gravelly drift with overlying marl and clay in the valley of the Severn, at Fleet's bank near Sandlin. Marine shells occur in the coarse drift, and freshwater shells in the superficial fluviatile deposits.

Mr. Strickland found remains of the Mammoth associated with Hippopotamus, Urus, &c. in the valley of the Avon, in apparently a local fluviatile drift, containing land and freshwater shells : this geologist supposes that after those parts of Worcestershire and Warwickshire had been long under the sea, an elevation of some hundred feet converted them into dry land, and that a river or chain of lakes then descending from the north-east, re-arranged much of the gravel of the great northern glacial drift, disposing it in thin strata and imbedding in it the shells of mollusks and the bones of the extinct quadrupeds.

In the centre of England, Dr. Buckland notices the occurrence of the Mammoth at Trentham in Staffordshire, in different parts of Northamptonshire, and at Newnham and Lawford, near Rugby in Warwickshire ; there the Mammoth's bones lay by the side of those of the Rhinoceros and Hyæna.

Mammoth-fossils occur at Middleton in the Yorkshire Wolds, in Brandsburton gravel-hills, and at Overton near York. Remains of the Mammoth, valuable from the condition of the ivory of the tusks, have been discovered at Atwick, near Hornsea, in the county of York.

In Scotland remains of the Mammoth have been found in the drift-clay between Edinburgh and Falkirk, at Kilmuir in Ayreshire.

In Ireland remains of the Mammoth have been found at Maghery in the county of Cavan, and in the drift near Tully-doly, county of Tyrone.

The celebrated cave at Kirkdale concealed remains of Mammoths : the molars here detected were all of small size ; very few of them exceed 3 inches in their longest diameter, and they must have belonged to extremely young animals, which had been dragged in by the Hyænas for food with Rhinoceroses, Hippopotamuses, and large Ruminantia.

The molars of the Mammoth which I have hitherto seen from the cave called Kent's Hole near Torquay are of similar young specimens ; here they are associated with the Hyæna, the great Cave Tiger, the Cave Bear, &c. : and I entirely accede to Dr. Buckland's explanation, that the bones or bodies of these young Mammoths were dragged into the cave by the Carnivora which coexisted with them.

Quitting the dry land and caves of Great Britain, we find the bed of the German Ocean a most fertile depository of the remains of the *Elephas primigenius*, and they are generally remarkable for their fine state of preservation.

Capt. Byam Martin, the harbour-master at Ramsgate, possesses several well-preserved specimens which have been from time to time brought up by the deep-sea nets of the fishermen, to whom this strange catching of elephants instead of turbot is a matter of disappointment and often of loss. A fine lower jaw of a young Mammoth, in the possession of Mr. G. B. Sowerby, was thus dredged up off the Dogger Bank, and a femur and portion of a large tusk, before described, were raised from 25 fathoms at low water, midway between Yarmouth and the Dutch coast.

Remains of the Mammoth have also been raised in the British Channel from the shoals called Varn and Redge, which lie midway between Dover and Calais.

These, therefore, with the fishing-banks above mentioned in the German Ocean, seem to be the furthest limits to which it is allowable to trace the remains of lost species in a record of the British Fossil Mammalia.

Indications of the Physical Forces which operated on the unstratified drift containing Bones and Teeth of the Mammoth.

The evidences of an enormous crushing and breaking power are very remarkably exemplified in some of the Mammalian fossils from the 'till' or drift at Walton in Essex. Mr. Brown of Stanway possesses molars of the Mammoth from this locality which have been split vertically and lengthwise, across all the component plates of dentine and enamel; other molars have been so crushed and squeezed that the enamel-plates are shivered in pieces, which are driven into the conglomerate of the different substances, and the fragments of enamel stick out like the bits of glass from the plaster which caps a garden wall.

The ramus of a lower jaw of a Rhinoceros from the drift near the sea-coast of Essex, has been split vertically and lengthwise through all the molars.

A similar condition of some of the mammalian fossil remains, including parts of the Mammoth, discovered by Mr. Stutchbury in a cavernous fissure at Durdham Down near Bristol, has been explained on the hypothesis of considerable relative movement having taken place in the walls of the fissure of the cavern since the deposit of the organic remains; and Mr. Stutchbury adduces, in confirmation of this view, the fact, that a calcareous spar-vein in the vicinity bears undoubted evidence of having been moved and reconstructed.

Other forces than the concussion of rocks by earthquakes seem, however, to have operated in producing the fractures of the teeth and bones in the beds of Essex gravel or drift above adverted to; and I cannot suggest any more probable dynamic, than the action of masses of ice, on the supposition of such being chiefly concerned in the deposition and dispersion of the superficial drift itself.

It is remarkable that the bones and teeth of the Elephant are very rarely rolled or water-worn; the fractured surfaces are generally entire, and sometimes the bones are found, like that in the Ashmolean Museum, in a remarkable state of integrity.

Genus *Mastodon*.

Remains of any species of this extinct genus are extremely rare in Great Britain, and have been hitherto only found in those deposits consisting of sand, shingle, loam and laminated clay, containing an intermixture of the shells of terrestrial, freshwater and marine Mollusca, which extend along the coast of Norfolk and Suffolk, and have been accurately described by Mr. Lyell under the name of the 'Fluvio-marine Crag.'

The first fossil submitted to my examination by Mr. Lyell from this formation, referable to the genus *Mastodon*, was a small part of the left superior maxillary bone containing the second true molar and the remains of the socket of the one anterior to it. The molar was not distinguishable from the corresponding one figured and described by Dr. Kaup in the magnificent remains of the *Mastodon* named by him *longirostris*, which were discovered in a similar fluvio-marine deposit at Epplesheim, Hesse-Darmstadt.

At present, however, I have not been able to appreciate the distinction between the molar teeth of the *Mast. longirostris*, Kaup, and those of the *Mast. angustidens*, Cuvier, the supposed specific distinction being, in fact, afforded by the form and proportion of the lower jaw, which may prove to be a sexual character. As the other molars of the *Mastodon* correspond equally with the *Mast. angustidens* and *Mast. longirostris*, I shall refer them to the species first defined by Cuvier. The British fossil above mentioned was discovered by Mr. J. B. Wigham in 1838, in the fluvio-marine crag at Postwick.

The first representation of any fossil relic of a Mastodon from British strata was given by William Smith: it forms the frontispiece of his original 4to work, 'Strata identified by Organized Fossils,' 1816. The fossil figured is the last molar tooth of the left side of the upper jaw of the *Mast. angustidens*, and was discovered in the fluvio-marine crag at Whitlingham, on the right bank of the Yare, within five miles of Norwich. The crown of the tooth supports five subalternate pairs of mammilloid cones, with a tuberculated posterior ridge: the summits of the first three pairs of cones are worn down by mastication, as in a corresponding molar of the *Mast. angustidens* from Peru, figured by Cuvier in the 'Ossemens Fossiles,' tom. i. Divers Mastodontes, pl. 1. fig. 6: the resemblance is extremely close.

Mr. Wigham likewise discovered a molar tooth of the *Mast. angustidens* in one of the pits excavated in the fluvio-marine crag at Thorpe near Norwich. Here, likewise, another molar tooth of the *Mast. angustidens* was found by Mr. Fitch of Norwich. Detached molars, or fragments of molars of the same species of Mastodon, have been discovered in the same formation, at Horstead by the Rev. J. Gunn, at Bramerton by the late Mr. Woodward, and at Easton cliff between Dunwich and Sizewell by Capt. Alexander, who possesses likewise two specimens from the sea-shore, washed out of the same fluvio-marine crag. Thus the not-long-since questionable occurrence of genuine mastodontal remains in England is placed beyond doubt: they have, hitherto, been exclusively found in a formation referable to the older pliocene division of the tertiary period.

Genus *Rhinoceros*.

The remains of this genus are much more abundant in this country than those of the Mastodon, and are associated in the more superficial strata with the remains of the Mammoth; extending, however, like these, as low as the fluvio-marine crag, but being more commonly found in caverns than are the bones or teeth of the more bulky Mammoth.

Those fossils of the Rhinoceros from British formations, hitherto examined by me and susceptible of satisfactory identification with determinate species, belong to the great two-horned *Rhinoceros tichorhinus* of Cuvier, which is associated in like manner with the Mammoth in Siberia. A few fossils have yielded indications of a second species.

Cuvier says with respect to a portion of the lower jaw discovered in digging a well at Thame in the county of Oxford, and formerly in the Leverian Museum, that, judging from the figure given of it in Douglas's 'Dissertation on the Antiquity of the Earth*,' it seems to belong to the *Rhinoceros leptorhinus*. I have not been able as yet to trace out this specimen, in order to ascertain how far the original would confirm the conjecture of Cuvier.

The molar tooth from the fluvio-marine crag at Bramerton, preserved in the Museum of Natural History at Norwich, has been supposed to belong to the *Rhinoceros leptorhinus*; it bears a closer resemblance to the corresponding

* 4to, 1785.

molar of the *Rh. Schleiermacheri* of Kaup, but a solitary molar tooth is not a very satisfactory ground for pronouncing absolutely of the species of Rhinoceros.

The most complete skeletons of one and the same individual have been found, as might be expected, in caverns or cavernous fissures, where the carcass of the fallen animal has been best protected from external changes and movements of the soil.

Dr. Buckland has recorded one of the most remarkable examples of this kind which was brought to light in the operation of sinking a shaft through solid mountain limestone, in a mining operation for lead-ore near Wirksworth, Derbyshire. A natural cavern was thus laid open, which had become filled to the roof with a confused mass of argillaceous earth and fragments of stone, and had communicated with the surface by a fissure or opening 58 feet deep and 6 feet broad, similarly filled to the top, where the outlet had been concealed by the vegetation. Near the bottom of this fissure, but in the midst of the drift, and raised by many feet of the same material from the floor of the cavern, was found nearly the whole skeleton of a Rhinoceros with the bones almost in their natural juxtaposition: one part of the skull which was recovered showed the rough surface for the front horn; the back part of the skull and one half of the under jaw were detached. All the bones were in a state of high preservation. There were no supernumerary bones to indicate the presence of a second Rhinoceros, but a few remains of Ruminants, apparently of extinct species.

A less proportion, but still a considerable one, of the skeleton of a tichorhine Rhinoceros was discovered by Mr. Whidbey, Engineer of the Plymouth Breakwater, in one of the cavernous fissures of the limestone quarries at Oreston, near Plymouth: the following parts, most of which were determined and have been figured by Mr. Clift, were recovered and preserved:—

Two molar teeth of the upper jaw.
Four do. do. lower jaw.
Portion of the first vertebra, atlas.
Portions of four dorsal vertebræ.
Portions of two caudal vertebræ.
Portions of four ribs.
The symphysial end of an os pubis.
Portions of the right and left scapulæ.
Both articular extremities of the left humerus.
Do. do. right ulna.
Do. do. left radius.
The right os unciforme.
The middle metacarpal bone of the right fore-foot.
A phalanx of the same toe.
Both articular extremities of the right femur.
Part of both extremities of the left femur.
The left patella.
A fragment of the left tibia.
Two portions of metatarsal bones of the right hind-foot.

The state of the epiphyses of the long bones indicate that the animal had not quite reached maturity; but in the same cavernous fissure there was found part of the right humerus of an older individual of the *Rhinoceros tichorhinus*.

The broken bones have suffered from clean fractures; none of them are gnawed or waterworn: the cavern containing them was 15 feet wide, 12 feet high, 45 feet long; it was filled with solid clay.

In similar and adjoining cavernous fissures, detached bones and teeth of

the same extinct species of Rhinoceros were found: they were associated in one of the fissures with remains of a large species of Deer and of the *Ursus spelæus*; in another fissure with fossil bones of *Equus*, *Bos*, *Cervus*, *Ursus*, *Canis*, *Hyæna*, and *Felis spelæa*: none of the bones exhibit marks of having been gnawed or broken by the teeth of the great cave-haunting Carnivora; but both these and the herbivorous species appear to have perished by accidentally falling into the cavernous fissures before these were filled up by the mud, clay and drift.

The abundant remains of the Rhinoceros discovered in the cave at Kirkdale tell a very different history: they manifest, as Dr. Buckland has demonstrated, abundant evidence of the action of the powerful jaws and teeth of the Hyænas, whose copros and other vestigia prove that ancient cavern to have been their habitual place of refuge. The fossil bones of the Rhinoceroses found in this cavern, as well as in that near Torquay, called Kent's Hole, belonged to animals which inhabited England during the period immediately preceding the deposition of the unstratified drift, and they coexisted with the Mammoth, Hippopotamus, huge Aurochs, Ox and Deer, which likewise became the occasional prey of the Hyænas, whose dwelling-place was thus converted into a kind of charnel-house of the large Herbivora.

The circumstances under which remains of the Rhinoceros have been discovered in the limestone caves of the Mendips, and in those on Durdham Down, lead to similar explanations of their introduction.

The humerus of a Rhinoceros was discovered, associated with remains of the *Hyæna spelæa*, in one of the caves in the carboniferous limestone at Cefn in Denbighshire, at a height of about 100 feet above the present drainage of the country.

Remains of the Rhinoceros were found associated with the entire under jaw of the old Hyæna in the drift at Lawford near Rugby; where likewise, as has already been stated, fossils of the *Elephas primigenius* were found.

With regard to the most instructive remains from this locality, as, for example, the cubitus, Cuvier expressly states that it belongs to the 'espèce cloisonnée*;' and again, with regard to the 'os innominatum,' that it seems to belong to the species with the osseous septum, viz. the *Rhin. tichorhinus*; and with regard to the tibia and the cervical vertebræ, Cuvier confines his observations to their differences as compared with the recent *Rhin. Indicus* (p. 84), or to their want of sufficiently distinguishing characters, p. 76.

Cuvier expressly refers the two skulls of the Rhinoceros discovered in the drift at Newhaven, 15 feet below the surface, to the *Rhin. tichorhinus*.

The teeth of the Rhinoceros from the cave at Kirkdale appear to me not to be distinguishable from those of the *Rhin. tichorhinus*.

The finest and most entire specimens of the tichorhine Rhinoceros from the superficial drift or freshwater formations are in the collection of John Brown, Esq., of Stanway. He possesses the upper part of the skull, 29 inches in length; showing the rough elliptical surfaces for the attachment of the two horns, and demonstrating more clearly than in any other British specimen, the osseous septum of the nose which characterizes the present extinct species. This specimen was discovered at Clacton: associated with it was a part of the lower jaw with the anchylosed symphysis, the length of which is 2 inches 9 lines, and its breadth across the alveoli of the second molar teeth 4 inches. Cuvier seems disposed to admit, from the testimony of Pallas, that the *Rhin. tichorhinus* might have had small incisive teeth in the lower jaw: every trace of their alveoli, if such had existed, have disappeared in the instructive specimen above noticed.

* Ossem. Foss. t. ii. pt. i. p. 80.

A right ramus of the lower jaw of the same species of Rhinoceros, discovered by Mr. Brown in the till at Walton in Essex, indicates, like the molars of the Mammoth described in the former part of this report, the action of enormous and peculiar forces posterior to their deposition in the matrix: it has been split vertically and lengthwise through the seven molar teeth which it contains, and in this clearly fractured state it was discovered when first exposed in the till; and to obviate an unnecessary length in the present report, I shall give the following citations of the discovery of the remains of Rhinoceros in British strata, in a tabular form.

Museum.	*Locality.*	*Stratum.*	*Parts.*
Norwich.	Bramerton.	Fluvio-marine crag.	Molar tooth.
Miss Gurney.	Mundesley.	Lacustrine blue clay.	Portion of lower jaw with three teeth.
Yorkshire.	Bielbecks.	Lacustrine blue clay.	Molar teeth*.
Ld. Enniskillen.	Maidstone.	Beneath the gravel. Pleistocene.	Atlas, and other bones and teeth.
Mr. Flower.	Ilford.	Pleistocene.	Upper molar.
Do.	Grays.	Do.	Lower molar.
Do.	Ilford.	Do.	Femur.
Mr. Bossey.	Wickham, near Woolwich.	Pleistocene.	Upper jaw, and bones.
Brit. Mus.	Drift near Canterbury	———	Molar tooth, described by Grew, Rarities of Gresham College, pl. xix. fig. 3.
Parkinson.	Fox Hill, Gloucestersh.	Drift.	Molar teeth.
Do.	Chatham.	Drift.	Molar teeth.
Mr. Morris.	Ilford.	Pleistocene.	Teeth.
Do.	Erith.	Do.	Teeth and phalanges.
Do.	Grays.	Do.	Teeth and bones.
Do.	Harwich.	Do.	Bones.
Do.	Kingsland.	Do.	Teeth.

Genus *Hippopotamus*.

Remains of this remarkable genus appear to have been first unequivocally determined by Mr. Trimmer† in a pleistocene formation at Brentford, overlying the London clay; they include several tusks, two lower incisors, an entire molar and the fragment of a second, and were discovered after penetrating through nine feet of brick-earth and seven feet of sandy gravel, in a stratum from one foot to nine feet deep of calcareous earth with freshwater shells: here the remains of the Hippopotami were associated with those of the Mammoth and of species of Deer. The locality is forty feet above the present level of the Thames. Six of the Hippopotamuses' tusks lay within an area of 120 yards. These fossils are referred by Cuvier to the extinct species which he has named *Hippopotamus major*.

Mr. Parkinson obtained from the till at Walton, in Essex, the following remains of the Hippopotamus:—a right lower incisor, the upper extremity of a lower canine, an anterior upper molar, and an ultimate lower molar tooth.

Dr. Buckland discovered molar teeth of the Hippopotamus in the Hyæna-cave at Kirkland, whence he infers that this pachyderm, like the Rhinoceros

* The Bielbecks fossils, Elephant, Rhinoceros, Felis, Urus, &c. &c., are all mentioned in Phillips's Geol. of Yorkshire, vol. i. (2nd edition).

† Philosophical Transactions, 1813.

and Elephant, had been the prey of the Hyænas, which inhabited England immediately preceding the formation of the drift.

The entire skull of a Hippopotamus, which was discovered in the drift-gravel below a peat-bog in Lancashire, is figured by Lee in his Natural History of that county.

Amongst the fossils of the Hippopotamus which I have personally examined from British strata, one of the finest is a considerable portion of the lower jaw, now in the museum of Miss Gurney, from the freshwater deposits overlying the fluvio-marine crag near Cromer. It contains six molars on one side, which occupy an alveolar extent of 1 foot. The first molar is separated by an interval of 9 lines from the second.

	In.	Lin.
The depth of the jaw at the third molar tooth is	4	9
From the back part of the last socket to the under margin of the descending angular process.	9	0

In the same rich collection there are several detached molar teeth of Hippopotamus from the same formation, a tusk 12 inches in length, and an incisor of the upper jaw; all establishing the identity of the present species with the *Hippopotamus major* of Cuvier, the remains of which occur in the drift of various parts of continental Europe.

In the Yorkshire Museum there is a molar tooth of the *Hippopotamus major*, from Overton near York.

In the Norwich Museum there is a tusk of the *Hippopotamus major*, which was dredged up from the oyster-bank at Happisburgh: it is black and heavy, being penetrated by iron.

Mr. Brown of Stanway possesses a portion of the tusk of the Hippopotamus from the till at Walton in Essex; it is referable to the *Hippopotamus major*: remains of the same extinct species have been found at Grays and Harwich.

Remains of the Hippopotamus have been found in several of the limestone caves in England besides that at Kirkdale; as, for example, at Kent's Hole, Torquay. Several teeth of the Hippopotamus were found, associated with Mammoth, Rhinoceros, Aurochs, Ox, Hyæna, and Bear, in the cavern at Durdham Down, recently described by Mr. Stutchbury.

Genus *Lophiodon*.

Prior to the year 1839, no fossils referable to any member of the Mammalian class had been detected in the eocene formation called the London and plastic clay. A fossil canine tooth brought up from a depth of 160 feet, out of the plastic clay, while sinking a well in the neighbourhood of Maidstone, unequivocally establishes the fact that the genus *Lophiodon* has contributed to the organic remains of that formation. For the opportunity of examining this rare and interesting fossil I am indebted to Mr. Alport, who has recorded the circumstances attending its discovery, with my note of identification, in his interesting work, 'The Antiquities and Natural History of the Town of Maidstone in Kent.' The size of the canine tooth agrees with that in the Lophiodon which Cuvier has called "La grande espèce d'Argenton," rendered by Fischer* *Lophiodon Isselense*, properly *Isselensis*. The matrix yielding the original fossils of this species is a freshwater hard marl, full of the shells of *Planorbis* and *Lymnæa*, with remains of Crocodiles and Trionyces.

The corresponding formation at Binstead in the Isle of Wight belongs to the eocene tertiary period, and has likewise furnished a fossil referable to the genus Lophiodon, and by its size to the *Loph. Isselensis*. It is a median phalanx of the right fore-foot, and was submitted to me as the bone of an Iguanodon. There is, in fact, a considerable general resemblance between the middle phalanges of this great herbivorous reptile and those of the larger hoofed Mammals; but with respect to the fossil in question, the configura-

* Systema Mammalium, p. 413.

tion of the lateral surfaces for the attachment of the ligaments; the production of the inferior border of the distal articulation into a process for the insertion of the flexor tendon; and the greater curvature or portion of a circle described by the distal articular extremity, which indicates a greater extent and freedom of flexion and extension of the toe than the cold-blooded reptiles possess; all prove the fossil to have belonged to the more agile, warmer-blooded and higher organized Pachyderm. This fossil phalanx forms part of the collection of the Marchioness of Hastings.

A fine fragment of the right ramus of the lower jaw, including the two posterior molar teeth, of a large *Lophiodon*, was dredged up from the bottom of the sea between St. Osyth and Harwich on the Essex coast. It is in the possession of Mr. Brown of Stanway.

Genus *Palæotherium*.

Most of the British fossils referable to this genus have been obtained from the freshwater eocene marls at Binstead or Seafield in the Isle of Wight. I am indebted for the opportunity of determining the specimens here recorded from this locality to Mr. S. P. Pratt, F.R.S., and the Rev. Darwin Fox. They are as follows:—

Palæotherium	*magnum*	. . . Antepenultimate molar, upper jaw.
.....	*medium*	. . . Posterior molar, lower jaw.
.....	Do.	. . . . . Portion of ditto ditto.
.....	Do.	. . . . . Posterior molar, upper jaw.
.....	Do.	. . . . . Penultimate molar, upper jaw.
.....	Do.	. . . . . Antepenultimate molar, upper jaw.
.....	Do.	. . . . . Anterior spurious molar.
.....	Do.	. . . . . Crown of canine.
.....	Do.	. . . . . Complete incisor.
.....	*crassum*	. . . Second molar, right side, lower jaw.
.....	*curtum* (?)	. . A molar tooth.
.....	*minus*	. . . . Portion of the base of the skull.
.....	Do.	. . . . . Right ramus of the lower jaw with six grinders.
.....	Do.	. . . . . Proximal end of the right radius.
.....	Do.	. . . . . Shaft and distal end of right tibia.
.....	*minimum*	. . Anterior molar tooth.

A shaft and distal articular end of a humerus, black, heavy and completely mineralized, from the eocene clay at Hordwell Cliff, Hampshire, in the collection of Mr. Wickham Flower, belongs to the genus *Palæotherium*, and agrees in its size and proportions with the humerus of the *Pal. crassum*. Mr. Wickham Flower likewise possesses an inferior molar tooth of a species of *Palæotherium*, corresponding in size with the *Pal. crassum*, from the same stratum and locality.

Genus *Anoplotherium*.

The remains of this genus have hitherto been met with in Great Britain only in the freshwater eocene deposits in the Isle of Wight, associated with quadrupeds of the same extinct genera as those with which the *Anoplotherium* was originally discovered by Cuvier in the eocene gypsum quarries at Montmartre. The British fossils consist of molar teeth referable to the *Anoplotherium commune* and *A. secundarium*.

Genus *Dichobunes*.

The most complete fossil referable to the Anoplotherioid family indicates a species of the subgenus *Dichobunes*, differing from those therein placed by Cuvier, and which I have named *Dich. cervinum**. The fossil consists of the

* Geological Transactions, 2nd Series, vol. iii. p. 451, and iv. p. 44. See also Annals of Philosophy, New Series, 1825, vol. x. p. 360.

posterior half of the left ramus of the lower jaw with the three true molar teeth: it was found in the lowest bed of the freshwater marl at Binstead.

Molar teeth of the same species of *Dichobunes* have been obtained by Mr. Flower from Hordwell Cliff, associated with the *Palæotherium crassum*, and with other lower organized Vertebrate fossils of the Eocene period, as *Crocodilus Spenceri*, *Trionyx*, *Palæophis*, *Lepidosteus*, &c.

Genus *Chœropotamus*.

Cuvier had recognized amongst the fossil fragments extracted from the gypsum at Montmartre, indications of extinct genera different from the *Palæotheria* and *Anoplotheria*, and to one of the rarest and least satisfactorily represented of these he gave the name of *Chœropotamus*. The fossil to be here noticed not only extends, by its association with the *Palæotheria* and *Anoplotheria*, the analogies of the eocene marls of the Isle of Wight with the gypsum beds at Paris, but affords additional information of the osteology and dentition of the extinct genus, which is essential to the determination of its exact affinities. The details of the comparisons illustrating this part of the history of the Chœropotamus are given in my paper in the Geological Transactions*; they show that the extinct Chœropotamus constituted one of the numerous examples in palæontology of lost links in the chain of animated nature, tending in the present case to connect the *Pachydermata* through the Hog-tribe with the plantigrade *Carnivora*.

The fossil in question is the right ramus of the lower jaw, with all the teeth in place except the second premolar and the incisors. It was discovered by the Rev. D. Fox in the Seafield quarry, near Ryde, Isle of Wight.

Genus *Hyracotherium*.

The freshwater eocene marls of the Isle of Wight are much richer in mammalian remains than the contemporaneous formation called the London clay; here, however, one genus, *Lophiodon*, has been found which exists in the eocene gypsum in France, the remains of which also occur in the eocene marls of the Isle of Wight; and the interesting fossil to be described in the present section, although it indicates a genus not, hitherto, found in the older tertiary beds on the continent, demonstrates the extinct quadruped of which it formed part to have been as distinct generically, as the *Anoplotherium* or *Palæotherium*, from any living Mammalia, and to have had the nearest affinity to the *Chœropotamus*.

The fossil in question consists of a mutilated cranium about the size of that of a hare, containing the molar teeth of the upper jaw nearly perfect and the sockets of the canines. It was discovered in the London clay forming the cliffs at Studd Hill, about a mile to the west of Herne Bay, by William Richardson, Esq., who kindly gave me the opportunity and permission of describing it.

The molars are seven in number on each side, and resemble more nearly those of the Chœropotamus than the molars of any other known genus of existing or extinct Mammalia. They consist of four premolars and three true molars.

The first and second premolars, counting from before backwards, have simple subcompressed crowns, surmounted by a single median conical cusp with a small anterior and posterior tubercle at the outer side, and a ridge along the inner side of its base: they are separated from each other by an interspace nearly equal to the antero-posterior diameter of the first premolar, which measures two lines and a half. The second and the remaining molars

* Geol. Trans. Second Series, vol. vi. p. 41.

are in close juxtaposition. The third and fourth premolars present a sudden increase of size and of complexity of the grinding surface, with a corresponding change of form. The plane or transverse section of the crown is subtriangular with the base outwards and nearly straight, the apex inwards and a little forwards, rounded off, to which the anterior and posterior sides converge in curved lines; the grinding surface supports three principal tubercles or cusps, two on the outer and one on the inner side: there are two smaller elevations, with a depression on the summit of each, situated in the middle of the crown, and the whole is surrounded with a ridge, which is developed into a small cusp at the anterior and external angle of the tooth. These teeth form the principal difference between the dentition of the present genus and that of the Chœropotamus, in which the corresponding false molars are relatively smaller and of a simpler construction, having only a single external pyramidal cusp, with an internal transverse ridge or talon at its base. The true molars, three in number on each side, closely correspond in structure with those of the Chœropotamus. They present four principal conical tubercles, situated near the four angles of the quadrilateral grinding surface. Each transverse pair of tubercles is connected at the anterior part of their base by a ridge, which is raised midway into a smaller conical tubercle with an excavated apex. The crown of the tooth is surrounded by a well-marked ridge, which is developed, as in the third and fourth false molars, into a sharp-pointed cusp at the anterior and external angle of the tooth. The hindmost molar is more contracted posteriorly, and its quadrilateral figure less regular than the two preceding molars.

The sockets of the canines or tusks indicate that these teeth were relatively as large as in the Peccari, and that they were directed downwards. The temporal muscles were as well-developed as in the Peccari, the depressed surface for their attachment extending on each side of the cranium as far as the sagittal suture.

The frontal bones are divided by a continuation of the sagittal suture. The nasal suture runs transversely across the cranium parallel with the anterior boundary of the orbits. The lachrymal bone reaches a very little way upon the face. The external angle of the base of the nasal bone, which is of considerable breadth, joins the lachrymal, and separates the superior maxillary from the frontal bone. The anterior margin of the malar bone encroaches a little way upon the face at the anterior boundary of the orbit. The external aperture of the sub-orbital canal is situated about three-fourths of an inch from the anterior boundary of the orbit. The under surface of the palatal processes of the maxillary bones is rugose, as in the Peccari; the portion of the skull, including the intermaxillary bones and the incisive teeth, is unluckily broken off and lost.

That the eye was full and large, is indicated by the size of the optic foramen and the capacity of the orbit, the vertical diameter of which equals 1 inch. The upper part of the cranium, anterior to the sagittal suture, is slightly convex from side to side; its longitudinal contour is nearly straight. The face gradually becomes narrower anteriorly; it is slightly concave at the sides.

The general form of the skull was probably intermediate in character between that of the Hog and the *Hyrax*. The large size of the eye must have given to the physiognomy of the living animal a resemblance to that of the Hare and other timid Rodentia.

Without intending to imply that the present small extinct Pachyderm was more closely allied to the *Hyrax* than as being a member of the same order, and similar in size, I have proposed to call the new genus which it unquestionably indicates, *Hyracotherium*, with the specific name *leporinum*.

In the eocene sand underlying the red crag at Kingston or Kyson in

Suffolk, from which the remains of *Quadrumana* have been obtained*, Mr. Colchester, the discoverer of those remains, has subsequently found the teeth of small mammalian animals, some of which are referable to the genus *Hyracotherium*†.

The teeth from Kyson are three true molars and one of the false molars, all belonging to the upper jaw. The crowns of the true molars present the same shortness in vertical extent, the same inequilateral, four-sided, transverse section, and nearly the same structure, as in *Hyracotherium leporinum* ; the grinding surface being raised into four obtuse pyramidal cusps, and surrounded by a well-developed ridge, produced at the anterior and outer angle of the crown into a fifth small cusp.

These teeth are, however, of smaller size, and differ in a point not explicable on the supposition of their having belonged to a smaller individual or variety ; for the ridge which passes transversely from the inner to the outer cusp is developed midway into a small crateriform tubercle in the teeth of the *Hyracotherium leporinum*, but preserves its trenchant character in the *Hyrac. Cuniculus,* even in molars which have the larger tubercles worn down.

The premolar in the series of detached teeth from Kyson, which is either the third or fourth, presents the same complication of the crown which distinguishes the *Hyracotherium* from the *Chœropotamus*, but with the same minor modification which distinguishes the true molars of the Kyson species from those of the *Hyrac. leporinum* of Herne Bay ; *i. e.* the two ridges which converge from the two outer tubercles towards the internal tubercle are not developed midway into the small excavated tubercle, as in the *Hyrac. leporinum,* but are simple. The disparity of size between the true and false molars appears to be greater in the *Hyrac. Cuniculus* than in the *Hyrac. leporinum.*

This discovery of a second species of the genus *Hyracotherium*, which, hitherto, has been found only in the London clay, tends to place beyond doubt the equivalency of the Kyson sand, underlying the red crag, with the eocene deposits at the estuary of the Thames.

I may add, that the collection of teeth and other small organic fragments from the Kyson clay, which included the molars of the small extinct Pachyderm above described, likewise contained several vertebræ of a serpent, agreeing in every respect, save size, with those of the *Palæophis toliapicus* from the Isle of Sheppey.

Genus *Sus.*

When Cuvier communicated his memoir on the fossil bones of the Hog to the French Academy in 1809, he had met with no specimens from formations less recent than the mosses or turbaries and peat-bogs, and knew not that any had been found in the drift associated with the bones of elephants. He repeats this observation in the edition of the 'Ossemens Fossiles' in 1822 ; but in the additions to the last volume published in 1825, Cuvier cites the discovery, by M. Bourdet de la Nievre, of a fossil lower jaw of a *Sus*, on the east bank of the lake of Neuchatel, and a fragment of the upper jaw from the cavern at Sandwich, described by Goldfuss.

Dr. Buckland ‡ includes the molar teeth and a large tusk of a boar found in the cave of Hutton in the Mendip Hills, with the true fossils of that receptacle, as the remains of the Mammoth, Spelæan Bear, &c. With respect to cave-bones, however, it is sometimes difficult to produce conviction as to the contemporaneity of extinct and recent species. MM. Croizet and Jobert, in their account of the fossils of Auvergne, give more satisfactory evidence of the coexistence of the genus *Sus* with *Elephas*, *Mastodon*, &c., by describing and figuring well-marked fossils of a species of Hog, which

* See Report of British Association for 1843.

† Geological Transactions, 2nd Series, vol. vi. p. 203. ‡ Reliq. Diluvianæ, p. 59.

they discovered "au milieu de nos couches à ossemens," in the midst of their rich fossiliferous tertiary beds. These observers found, however, that the facial part of their fossil Hog was relatively shorter than in the existing *Sus scrofa*, and they have conceived it to represent a distinct species, viz. the *Sus Avernensis*. Dr. Kaup has described fossils referable to the genus *Sus* from the miocene Epplesheim sand, in which they were associated with fossils of the *Mastodon* and *Dinotherium*.

The oldest fossils of the genus *Sus* from British strata which I have yet seen, are portions of the external incisor of the lower jaw, from fissures in the red crag (probably miocene) of Newbourne near Woodbridge, Suffolk. They were associated with teeth of an extinct *Felis* about the size of a leopard, with those of a bear, and with remains of a large *Cervus*. These mammalian remains were found with the ordinary fossils of the red crag; they had undergone the same process of trituration, and were impregnated with the same colouring matter as the associated bones and teeth of fishes acknowledged to be derived from the regular strata of the red crag. These mammaliferous beds have been proved by Mr. Lyell to be older than the fluvio-marine or Norwich crag, in which remains of the Mastodon, Rhinoceros and Horse have been discovered; and still older than the freshwater Pleistocene deposits from which the remains of the Mammoth, Rhinoceros, &c. are obtained in such abundance.

I have met with some satisfactory instances of the association of fossil remains of a species of Hog with those of the Mammoth in the newer pliocene freshwater formations of England.

In the collection of Mr. Wickham Flower there are good specimens of the teeth of the Hog (molars, and a long and sharp tusk), which were taken from the brick-earth at Grays in Essex, twenty feet below the present surface; these teeth were associated with teeth and bones of a deer, and portions of dark charred wood. Mr. Brown of Stanway has likewise some fossil remains of a young specimen of *Sus* from the freshwater deposits at Grays.

A left upper tusk of a Boar from the Pleistocene beds near Brighton presented a broader longitudinal internal strip of enamel than in those tusks of the Wild Boar of Europe or India which I had for comparison; the longitudinal groove along the unenamelled part was deeper.

These instances of fossil remains of the Hog tribe are, however, very rare. The usual situation of bones of the Hog is that mentioned by Cuvier in peat-bogs. In the Norwich Museum there is the anterior part of the lower jaw of a Hog, which was found four or five feet below the surface in peat-bog upon drift-gravel.

A molar tooth with the upper and lower tusks of a Wild Boar have been found, associated with remains of the Wolf, Beaver, Goat, Roebuck, and large Red-deer in freshwater marl, underlying a bed of peat 10 feet thick, itself covered in some places by the same thickness of shell-marl and alluvium, at Newbury, Berkshire.

In the most recent deposits where the remains of the Hog are usually met with, their identity with the *Sus scrofa* is unequivocal.

I have received from Dr. Richardson a collection of bones, not much altered by time, from a gravel-pit in Lincolnshire, near the boundary between the parishes of Croft and Ikeness; among these were remains of the common Hog.

The tusks and molar teeth of a Boar which were discovered, ten feet below the surface of a peat-bog, near Abingdon, Berkshire, were associated with quantities of hazel-nuts in a blackened or charred state, the whole resting on a layer of sand which was traced extending eighteen feet horizontally.

The anterior part of the left ramus of the jaw of a Hog has been obtained from the drift formation at Kesslingland, Suffolk.

Genus *Equus*.

In England, as on the Continent, remains of the genus *Equus* attest that a species equalling a middle-sized Horse, and one of the size of an Ass, or Zebra, have been the associates of the Mammoth, Rhinoceros, and other extinct quadrupeds whose remains are so generally dispersed in the drift formations, bone-caves, and the newer tertiary deposits. Almost every geological author who has had occasion to notice the mammalian fossils of these recent periods has made mention of such a combination. It has been observed by Dr. Mantell* in the "Elephant-bed" at Brighton; by Mr. Clift† in the cavernous fissures at Oreston; by Dr. Buckland‡ in the ossiferous caves at Kirkdale, in the Mendips and at Paviland; by Mr. Lyell§ in the tertiary deposits on the Norfolk coast; by Col. Hamilton Smith‖ in the bone-caves near Torquay; and by Mr. Morris¶ in the mammaliferous deposits in the valley of the Thames, as at Wickham, Ilford, Erith, Grays and Kingsland.

No critical anatomical comparison appears hitherto to have been instituted with regard to the relations of these equine fossils with the existing species. That the fossils vary in size amongst themselves has been more than once noticed; and Dr. Buckland makes a remark** expressive of his suspicion that they belonged to more than one species.

The largest-sized fossil *Equus* from British strata is indicated by a molar tooth, the second of the left side, lower jaw, obtained by Mr. Lyell from a bed of laminated blue clay, with pyrites, eight feet thick, overlying the Norwich crag at Cromer, where it was associated with remains of the *Mammoth*, *Rhinoceros*, *Bos*, *Cervus*, and *Trogontherium*. The antero-posterior diameter of this tooth was 1 inch 4-10ths, equalling that in the largest dray-horses of the present day: other corresponding fossil teeth of *Equus* have measured in the same diameter 1 inch 2-10ths, and 1 inch. The intermediate size, which equals that of the teeth of a horse of between fourteen and fifteen hands high, is the most common one presented by fossils. A middle upper molar tooth from Kent's Hole, Torquay, indicates a horse as large as that from the blue clay at Cromer, but the size of the fossil species would be incorrectly estimated from the analogy of the teeth alone. Although the equine fossils are far from rare, yet they have hitherto in England been always found more or less dispersed or insulated, and no opportunity has occurred of ascertaining the proportions of one and the same individual by the comparison of an entire skeleton with that of the existing species of *Equus*.

The best-authenticated associations of bones of the extremities with jaw and teeth, clearly indicate that the fossil Horse had a coarser and larger head than in the domesticated races; resembling in this respect the Wild Horses of Asia described by Pallas††, and in the same degree approximating the Zebrine and Asinine groups.

It is well known that Cuvier failed to detect any characters in the skeletons of the different existing species of *Equus*, or in the fossil remains of the same genus, by which he could distinguish them; except by their difference of size, which yields but a vague and unsatisfactory approximation.

The second and third molars of both jaws in every fossil specimen of these teeth which I have examined, are narrower transversely in comparison with their antero-posterior diameter than in the existing horse; and a similar character appears to have been recognized by M. H. v. Meyer in the fossil equine teeth from continental localities, since he cites the *Equus angustidens*

* Fossils of the South Downs, 4to. 1822, p. 283.
† Phil. Trans. 1823, p. 86.
‡ Reliquiæ Diluvianæ, pp. 18, 75.
§ Phil. Mag. vol xvi. (1840), pp. 349, 362.
‖ Naturalist's Library, Horses, p. 63.
¶ Mag. of Nat. History, 1838, p. 539.
** *Loc. cit.* p. 75, with respect to the equine remains discovered in the Oreston caverns:—"Horses about twelve, of different ages and sizes, as if from more than one species."
†† Zoographia Rosso-Asiatica, tom. i. p. 255.

as a synonym of the species which he subsequently described under the name of *Equus asinus primigenius**.

Amongst the numerous teeth of a species of *Equus*, as large as a horse fourteen and a half hands high, collected from the Oreston cavernous fissures, I have found specimens clearly indicating two distinct species, so far as specific differences may be founded on well-marked modifications of the teeth.

One of these, like the ordinary *Equus fossilis* of the drift and pleistocene formations, most resembles the existing *Equus caballus* in its dental characters; the other, in the more complex and elegant plication of the enamel, and in the bilobed posterior termination of the grinding surface of the last upper molar, more closely approximates the extinct Horse of the miocene period which H. v. Meyer has characterized under the name of the *Equus caballus primigenius*†. The Oreston remains differ, however, from this in the form of the fifth or internal prism of dentine in the upper molars, and in its continuation with the second anterior prism; the fifth prism being oval and insulated in the *Equus primigenius* of V. Meyer.

The Oreston fossil teeth, which in their principal characters manifest so close a relationship with the miocene *Equus primigenius*, differ like the later drift species (*Eq. fossilis*) from the recent Horse, in a greater proportional antero-posterior diameter of the crown of the second upper molar, and also in a less produced anterior angle of the first molar. In neither of the fossil species is the entire tooth so much curved as in the extinct *Equus curvidens*, nob., the contemporary of the Megatherium in South America.

The more common species of fossil Horse from the drift formations and ossiferous caverns, which differs from the existing domestic Horse in its larger proportional head and jaws, resembling in that respect the Wild Horse, but apparently differing in the transversely narrower form of certain molar teeth, may continue to be conveniently indicated by the name of *Equus fossilis*, as Cuvier's "cheval fossile" has been translated by M. H. v. Meyer‡. Of this species, the largest bone of an extremity which I have seen, is a second phalanx from the upper pliocene deposits at Walton-on-Naze, Essex, where it was discovered by Mr. Brown of Stanway; it measures 2 inches 8 lines in extreme breadth, and 2 inches 4 lines in length. The corresponding bones from Oreston are smaller.

The contemporary but distinct species, indicated by the teeth above described from the Oreston caverns, I propose to name *Equus plicidens*, on account of the characteristic plications of the enamel-island in the centre of the molar teeth. I have not yet seen any teeth from British strata having the well-marked characters of those of the *Equus caballus primigenius* of M. H. v. Meyer; but the teeth of the extinct slender-legged Horse, transmitted by Capt. Cautley to the British Museum, are identical with those of the above species from the European miocene.

In the more recent or diluvial formations, a fossil species of *Equus*, smaller than any of the preceding, and about the size of the Wild Ass, is indicated by molar teeth. Of these I may cite a middle molar of the left side of the upper jaw, from the drift overlying the London clay at Chatham; a corresponding molar from the opposite side of the upper jaw, from the drift at Kesslingland in Suffolk; and a fifth molar, left side of lower jaw, from a cavernous fissure at Oreston: all these teeth were in the same fossilized condition as the associated remains of extinct Mammals with which they had clearly been contemporaneous. If we admit the subgeneric separation of those species of the genus *Equus*, Cuv., that have callosities on the fore-legs only, the tail furnished with a terminal brush of long hair, and a longitudinal dorsal line, the last indicated fossil species may be named *Asinus fossilis*.

* Palæologica, p. 80.

† Nova Acta Acad. Nat. Curios. tom. xvi. p. 448.

‡ Palæologica, p. 79.

Several bones of a large Ass were associated with the teeth of the Wild Boar above mentioned, from the marl beneath the peat formation at Newbury, Berks.

I have been favoured with the following notes of the discovery of fossil teeth of a species of *Equus* in Ireland, by John Thompson, Esq. of Belfast. In sinking a well near Downpatrick, in the county of Down, two teeth were found in a stratum of gravel far below the present surface. A tooth was found at Newry under similar circumstances. In the county of Antrim teeth of the Horse have been found four feet below the surface in drift gravel near Belfast, and at the bottom of a turf-bog near Broughshane.

Order Ruminantia.

Family Bovidæ.

Subgenus *Urus**.

Urus priscus, Fossil Aurochs.

The former existence of a gigantic species of this subgenus is unequivocally established by fossil remains of the cranium and horn-cores from various newer tertiary freshwater deposits, especially in Kent and Essex.

One of these specimens was dug out of a stratum of dark-coloured clay below layers of brick-earth and gravel, thirty feet below the surface, at Woolwich; it presents the broad convex forehead, the advanced position of the horns, which rise three inches anterior to the upper occipital ridge, and the obtuse-angled junction of the occipital with the coronal or frontal surface of the skull, all which characters distinguish that part of the skeleton of the Aurochs. The bony cores of the horns extend outwards, with a slight curvature upwards: from the mid-line between their bases to the extremity of one core, in a straight line, measures 2 feet 5 inches.

Another specimen of the fossil cranium of the *Urus*, dug out of a brick-field at Ilford in Essex, presents, with the same essential characters as the preceding, relatively thicker, shorter and more curved horn-cores. This fossil in the shorter horns differs from the preceding, as the American Bison or Ass differs from the European Aurochs; but in the absolute length of the horns it resembles the European Aurochs: it may indicate the female *Urus priscus*.

A broken skull with perfect horn-cores of the *Urus priscus*, discovered by Mr. Strickland in the freshwater drift at Cropthorne, Worcestershire, yields the following dimensions: from tip to tip of the horn-cores, following the anterior curves, 3 feet 8 inches; the same in a straight line, 3 feet 4 inches.

Hitherto no fossil skeleton of the same individual has been discovered in a state of such completeness as to enable the anatomist to ascertain the number of the ribs; a fact which would be of singular importance in determining the relations of the ancient British Aurochs, since the European existing Wild Aurochs has fourteen pairs, and the American Aurochs or Bison has fifteen pairs, whilst all the varieties of Ox and Buffalo have but thirteen pairs of ribs. The number of the true vertebræ is however the same in all the Bovine animals, the costal or dorsal being increased at the expense of the lumbar series in the subgenus *Urus*. Cuvier expresses his opinion of the importance of a precise knowledge of the formations containing remains of the great fossil Aurochs, and regrets that the information on this point is somewhat vague.

The brick-earth from which the two specimens of fossil Aurochs above-cited were found, underlies a layer of sand with pebbles and concretions, containing shells of *Unio* and *Cyclas*; and the remains of both Mammoth and Rhinoceros are unquestionably associated with those of the Aurochs in this formation. The other localities which may be cited, from the less certain character of the

* *Bos Urus*, Linn., but not the *Urus* of the ancients, which Cuvier regards as the true original of our domestic cattle.

proportion of the metacarpal and metatarsal bones—those of the slenderest proportions being referred to the Aurochs,—are Brentford, Wickham, Ilford, Erith, Woolwich, Grays, Whitstable, Gravesend, Copford, and Clacton.

Prof. Phillips has recorded the discovery of the skull with the cores of the horns and the teeth of the great Aurochs at Beilbecks in his 'Geology of Yorkshire,' vol. i. 2nd edition, accompanied by land and freshwater shells, and by remains of the Mammoth, Rhinoceros, Felis, large Horse, large Deer, Wolf, &c.

Subgenus *Bos*.

Bos primigenius, Bojanus. *Bœuf fossile*, Cuvier.

The fortunate discovery of the cranium and horn-cores of this great extinct species in drift and recent tertiary deposits in this country, has enabled me to enter it without hesitation in the list of British Fossil Mammalia, and at the same time to determine its equal antiquity with the Aurochs. The characters of the *Bos primigenius*, as contrasted with the *Urus priscus*, may be advantageously studied in the magnificent specimen of an almost entire skeleton discovered in the drift overlying the London clay at Herne Bay, and now in the collection of Mr. Wickham Flower. The concave forehead with its median longitudinal ridge; the origin of the horns at the extremities of the sharp ridge which divides the frontal from the occipital regions; the acute angle at which these two surfaces of the cranium meet to form the above ridge, all identify this specimen with the *Bos primigenius* described by Cuvier*, Bojanus† and Fremery‡. The cores of the horns bend at first slightly backward and upward, then downward and forward, and finally inward and upward, describing a graceful double curvature: they are tuberculate at the base, moderately impressed by longitudinal grooves, and irregularly perforated: the length of each horn-core along the outer curve is 3 feet 3 inches; the circumference of the core at its base 18 inches 10 lines; the longest diameter of the base $6\frac{1}{2}$ inches; the chord of the arc described by the core is $7\frac{1}{4}$ inches; from the middle line of the forehead to the tip of the core is 2 feet 2 inches.

The length of the lower jaw of this specimen is 1 foot 8 inches; that of the series of molar teeth is 7 inches. All the true vertebræ except the atlas appear to have been recovered, and they include the six remaining cervical vertebræ; thirteen dorsal and six lumbar vertebræ; thus yielding another important character by which this great primeval Ox agrees with the domestic species of the present day. One of the dorsal vertebræ which retains its spinous process measures 1 foot 7 inches in height; a development not greater than might have been expected for the support of the head and horns. One of the scapulæ shows a diseased external surface, ossific inflammation having extended from two depressions in the bone, probably inflicted by the horns of another bull in conflict. The metacarpal bones give additional exemplifications of the true Bovine character of the present extinct species, by their stronger proportions as compared with those of the Aurochs; the length of one being 10 inches, and its circumference $5\frac{1}{2}$ inches.

Mr. Brown of Stanway has recorded his discovery, in a mass of drift-sand overlying the London clay at Clacton on the Essex coast, of the frontal part of the cranium, with the cores of the horns of a large Bovine animal, which, from the direction and degree of curvature of the horns, agrees with the fossil *Bos primigenius*. Each core measured 3 feet along the outer curve from the base to the tip; the chord of the arc of such curve being 8 inches: the diameter of the base was 6 inches in one direction and 5 inches in the other. With these parts of the *Bos primigenius* was found a perfect Mammoth's tooth, 11 inches in length, 8 inches in depth, and 3 inches across the grinding surface.

* Ossem. Foss. iv. p. 150. † Nova Acta Acad. Nat. Cur. xiii. pt. 2.

‡ N. Verh. Koninkl.-Nederlandsch Instituut, Derde Deel, 1831.

The most complete skull of the *Bos primigenius* is that of which the discovery is recorded in the Bath and Cheltenham Gazette for June 26, 1838. The specimen was obtained from the bed of the river Avon, at Melksham, Wilts, and it gives a distinctive character of the present subgenus which could not be deduced from the former specimens on account of their fractured state, viz. the greater length of the frontal region in proportion to its breadth, as compared with that part of the skull of the *Urus*.

Cuvier states with regard to fossil remains of the *Bos primigenius*, "il s'en trouve en Angleterre," apparently on the authority of drawings transmitted to him by Mr. Crow.

Mr. Parkinson* refers his specimens of Bovine fossils dug up in Dumfriesshire to the *Bos primigenius*, but without assigning the grounds for this choice. Cuvier himself devotes a distinct section to the detached fossil bones of the trunk and extremities of the Bovine tribe, expressing his regret at the numerous sources of uncertainty and difficulty attending their determination when unassociated with the skull; whilst he acknowledges the great importance of ascertaining the species of *Bovidæ* to which the bones from each stratum belonged; whether, for example, an Aurochs, an Ox, or a Buffalo had been the companion of the Elephants, Rhinoceroses, &c. which formerly lived in climates of Europe. At the period of the publication of the second edition of the 'Ossemens Fossiles' (1823), no authentic example had been recorded of a cranium of either *Urus priscus* or *Bos primigenius* in strata containing bones of the Mammoth and Rhinoceros; and this statement is repeated in the posthumous edition of the 'Ossemens Fossiles,' 8vo, 1835. The two examples above cited of crania of the *Urus priscus* from newer pliocene freshwater deposits in Kent and Essex, leave no reasonable doubt that a large Aurochs was the associate of the gigantic *Pachyderms*, whose representatives at the present day have the Buffalos for their companion in the tropical swamps and forests. It is true that species of true *Bos* are found wild in the warmer parts of Asia; but no true Aurochs has been discovered within the tropics. The great fossil *Urus* was likewise associated with as large a species of *Bos* in England during the period antecedent to the deposition of the drift.

To determine to which subgenus of *Bovidæ* detached teeth, vertebræ, ribs and other bones of the skeleton belonged, is still attended with much difficulty; such remains, however, sufficiently attest that species as large as the *Urus priscus* and *Bos primigenius* were very extensively distributed throughout England: they have been found in almost all the drift and cave localities, and in the newer tertiary deposits that have been cited in the foregoing part of the present report as yielding the fossil remains of *Elephas*, *Rhinoceros*, *Hyæna* and *Ursus*.

Cuvier† affirms, as the result of his numerous comparisons of the recent and fossil bones of the Bovine animals, that the detached bones resemble each other too much to yield certain specific characters, and that it is necessary to have skulls in order to determine the species. I have however noticed a character in a few fossil metatarsal bones of different sizes from the cavernous fissures at Oreston, and from the freshwater tertiary deposits in Essex, which I have not observed or found recorded in any known existing species of the Bovine family, and which would serve easily and unequivocally to determine the fossil species if once these bones could be found in such connexion or juxtaposition with a cranium as to justify the conclusion that they belonged to the same skeleton with such cranium. At present, unfortunately, this link, essential to a reference of the bones in question to their true subgenus, is wanting, and I can only cite them with a notice of the peculiar character

* Organic Remains, vol. iii. p. 325.

† Ossem. Foss. iv. p. 140.

adverted to, in the hope that some fortunate ulterior discovery may determine whether they belong to a species of Aurochs (*Urus*), or of Ox (*Bos*), or some other subgenus of a Bovine family.

The character in question is an unusual prominence of the inner border of the anterior groove for the extensor tendon which traversed the middle of that surface of the metatarsal bone, bending the groove obliquely outward; it is well shown in a large fossil metatarsal bone, heavily impregnated with iron, from the freshwater formation at Clacton, Essex, and now in the collection of Mr. Brown. I should perhaps have regarded this production of a ridge of bone as due to ossific inflammation, had not two fossil metatarsal bones of a smaller Bovine animal, from the cavernous fissures at Oreston, presented the same character. Both these metatarsals and the larger one from Clacton present more slender proportions than those of the *Bos primigenius*, and in the same degree approach the genus *Urus*.

Bos longifrons.

This species belongs to the subgenus *Bos*, by the form of the forehead and the origin of the horns from the extremities of the upper occipital ridge, but is distinguished from the *Bos primigenius* by its much smaller size, its much shorter horns in proportion to its size, and by its longer and narrower forehead. The horns have a simple curvature forward, and a little downward. Remains of this species were first described by Robert Ball, Esq., Secretary to the Zoological Society of Dublin, in the Proceedings of the Royal Irish Academy for January 1839, as indicating "a variety or race differing very remarkably from any previously described in works with which the author was acquainted." They consisted principally of parts of the skull with the horn-cores, which had been found at considerable depths in bogs in Westmeath, Tyrone and Longford.

One of the specimens from Westmeath gives the following admeasurements:—

	In.	Lines.
Length from the supra-occipital ridge to the nasal bones....	8	0
Breadth of the skull between the roots of the horns	5	5
Breadth of the skull across the middle of the orbits.....	6	5
Circumference of base of horn-core	4	3
Length following outer curvature	3	6

In the Hunterian collection there is a frontlet and horn-core of the same species likewise obtained "from a bog in Ireland." Had no other localities for the *Bos longifrons* been known, it might have been held to be of later date than the *Bos primigenius* and *Urus priscus*, of whose existence as the contemporaries of the Mammoth and tichorhine Rhinoceros we have the most satisfactory evidence; I have however been so fortunate as to ascertain, in the survey of the collections of Mammalian Fossils in the Eastern Counties, indubitable specimens of the *Bos longifrons* from freshwater deposits, which are rich in the remains of *Elephas* and *Rhinoceros*.

A specimen of the back part of the cranium and horn-cores in the collection of Mr. Brown of Stanway, obtained by that gentleman from the freshwater deposits at Clacton on the Essex coast, gives the admeasurement from the supra-occipital ridge to the upper margin of the foramen magnum, which is 3 inches 9 lines; the breadth of the skull between the roots of the horns is 5 inches.

A fossil frontlet and horn-cores of the *Bos longifrons*, from a similar freshwater of the newer pliocene period, at Walton, presents the same characters as the specimens from below the Irish bogs, and it is interesting to find that remains of the gigantic Deer (*Megaceros*) are associated with the *Bos longifrons* in the English freshwater deposits, as in the under-bog marls in Ireland.

Remains of the *Bos longifrons* occur in the freshwater drift at Kensington, associated with those of the Mammoth.

The above-described contemporaneous fossil remains of Bovine animals from the British newer tertiary and drift formations clearly establish the important fact, that species of that subgenus, to which belong the domesticated races of the Ox, are as ancient as those of the subgenus *Urus*, now represented by the great Aurochs of the Lithuanian forests; and that the distinguishing characters of that wild race have not needed to be modified to produce the domestic breed, since wild species of *Bos*, as distinct as the domestic Ox now is from the Lithuanian Aurochs, coexisted with a gigantic species of *Urus* during the later tertiary periods of geology.

Genus *Capra*.

Frequent evidence of the smaller ruminating animals is afforded by fossil jaws, teeth and detached bones of the skeleton, and in a few cases by the characteristic appendages of the skull—horns or antlers, which then serve to identify the species or the genus of such fossils.

A fragment of a lower jaw, containing one of the lateral series of six molar teeth, with a part of the skull having the perfect cores of the horns attached, was discovered by Mr. Brown in the newer pliocene deposits at Walton in Essex: these fossils were in the same condition as the bones of the large extinct Mammalia from the same formation. The jaw and teeth agreed in size and configuration with the same parts in the common Goat, and also in the Sheep; and the highly interesting question, which of these had existed contemporaneously with the Mammoth and Rhinoceros, was satisfactorily determined by the cranial fragment: in its shape and size, and especially in the character of the cores of the horns, which were 2 inches in length, subcompressed, pointed, directed upwards, with a slight bend outwards and backwards, it closely agreed with the common Goat (*Capra Hircus*), and with the short-horned female of the Wild Goat (*Capra Ægagrus*), the probable origin of the half-domesticated Goat of Europe.

Whether the *Capra Ægagrus* or the *Capra Ibex* should be regarded as the stock of our domestic breed, has long been a question among naturalists; the weighty argument which may be drawn from the character of the wild species which was contemporary with the *Bos primigenius* and *Bos longifrons*, is shown by the present fossil to be in favour of the *Capra Ægagrus*.

Genus *Cervus*.

Subgenus *Capreolus*.

In the collection of British fossils belonging to Mr. Purdue of Islington, there is an entire left ramus of the lower jaw of a small Ruminant, identical in size and conformation with that of the Roebuck (*Cervus Capreolus*). It was found in a lacustrine deposit of marl, with freshwater shells, below the bed of peat, at Newbury in Berkshire. Antlers of the Roebuck have been found at ten feet deep below the fen-land of Cambridgeshire. The characteristic antlers, with portions of the jaws and teeth of the Roebuck, have been found in the bone-caves in Pembrokeshire, and in the neighbourhood of Stoke-upon-Trent. I have been favoured with specimens from the limestone caverns of the latter locality by Robert Garner, Esq., the author of the 'History of Staffordshire.' Almost the entire skeleton of a small Ruminant, agreeing in size and general characters with the female Roe, has been discovered in the lacustrine formation at Bacton, with the remains of the Trogontherium, Mammoth, &c.

Subgenus *Elaphus*.

A large round-antlered Stag, nearly allied to, if not a variety of, the existing Red Deer (*Cervus Elaphus*, Linn.), was the associate of the great Aurochs,

the Mammoth and the Rhinoceros, and its fossil remains have been discovered in almost all those formations and localities which have yielded those of the before-mentioned extinct Mammals.

The oldest stratum yielding evidence of a *Cervus* of the size of the Red Deer, is the Miocene Red Crag at Newbourne, and remains of this species attest its existence through intermediate strata up to the period of the formation of the turbaries and peat-bogs.

Dr. Buckland makes mention of the discovery of an entire skull of a Deer, in the bone-cave at Paviland, as large as a Red Deer, but of a different species. The rounded base of a shed antler, measuring 3 inches in diameter above the brow-antler, and sending forwards the second or bezantler within three inches of the former, indicates a species of the Elaphine group, equalling the *Cervus Megaceros* in the size of the beams of the antler; and therefore, from the known proportions of the body to the antlers in the Red Deer, probably exceeding that great extinct species from the Irish bogs in size, and at least equalling the Wapiti Deer (*Cervus Canadensis*, Brisson). The fossil in question was found in Kent's Hole, where also remains of the *Megaceros* occur.

Subgenus *Dama*.

Antlers slightly palmated, most nearly resembling those of the Fallow Deer (*Cervus Dama*, Linn.), with teeth, portions of jaws and other bones agreeing in size with those parts in the Fallow Deer, have been found in several of the newer tertiary deposits and the bone-caves of England, associated with the usual extinct Mammalia. I received similar remains with the tusks of the Wild Boar from the marl under the peat-moss at Newbury.

The lower jaw of a Deer, about the size of the Fallow, occurs in the pliocene at Bacton.

Subgenus *Megaceros*.

Megaceros Hibernicus.

The most remarkable of the unquestionably extinct species of the Cervine family is that which is commonly called the Irish Elk. The most abundant and the most perfect examples of this noble animal have been furnished by the bogs of Ireland, where they occur below the peat in the lacustrine marl, but the species is by no means peculiar to Ireland; an entire skeleton having been found in the newer pliocene deposits in the Isle of Man, and characteristic portions of the skeleton and antlers in freshwater deposits of a corresponding age, and in some of the bone-caves of England.

Dr. Molyneux*, the original describer of the antlers of the *Megaceros*, points out their distinction from the true Elk, and the true affinities of the extinct species have been more exactly determined by Cuvier and later anatomists.

The rounded beam of the antler expands, sooner than in the true *Dama*, into a broad palm, which sends off all the processes or snags, save one, from its anterior border, in which respect *Megaceros* differs from *Dama* and resembles *Alces*; it differs from the Elk in having one posterior branch or 'spiller,' and more especially in having both brow-antler and bezantler. The Reindeer (*Rangifer*) makes the nearest approach to the *Megaceros* in the large development of the antlers, but the extinct species far surpasses all known *Cervidæ* in the enormous proportions of the antlers as compared with the skull. In the occasional bifurcation of the expanded end of the brow-antler it again approximates the characters of the Reindeer (*Rangifer*), but does not push its affinity to this genus so far as to have antlers developed in both sexes, as Cuvier suspected.

* Philos. Trans. vol. xiv. p. 489.

My friend Col. Hamilton Smith, the founder of the subgeneric divisions of the Linnæan *Cervus*, has referred the gigantic Deer of Ireland to the section *Dama*, or the Fallow Deer*; but the peculiar proportions and modifications of the antlers of the extinct species in question afford as good grounds for a special subgenus for its reception, as those on which the subgenus *Dama* itself has been proposed.

I subjoin the following dimensions of the skull and antlers of a few of the most perfect specimens that have come under my notice:—

	No. 1, ft. in.	No. 2, ft. in.	No. 3, ft. in.
Length of skull	1 7	1 8	1 7
Between the extreme tips of the antlers in a straight line	8 4	8 9	9 2
Length of a single antler, following its curve	5 9	7 3	5 10

The difference in the extent of the interspace between the tips of the antlers depends on their direction and degree of curvature. Dr. Hart states that it is not uncommon to find the fossil antlers 10 feet between the extreme tips; the same interspace between the largest antlers of the true Elk does not exceed 4 feet.

With regard to the skeleton, if the peculiar size and strength of the cervical vertebræ in the male *Megaceros* be excepted, which have a physiological adaptive relation to the enormous weight of the head when the antlers are fully developed, the forms and proportions of all the other bones, and especially those of the nose and of the upper and lower jaws, closely agree with the type of the Fallow and Reindeer.

Prof. Phillips first described the skull of the female *Megaceros*, and showed that, as in the typical Deer, it had no trace of antlers.

I have had the opportunity, through the kindness of the Earl of Enniskillen, of examining three other skulls of the female *Megaceros*. The skull in this sex is chiefly characterized by a longitudinal angular prominence, which rises from the posterior half of the frontal suture, and very much resembles the median prominence, sometimes called the third horn of the Giraffe. An irregular subquadrangular vacancy intervenes between the angular extremities of the frontal, nasal, lachrymal and superior maxillary bones. The roof of each orbit is perforated by a circular foramen, smaller than in the male.

The earliest observations bear testimony to the abundance of the remains of the *Megaceros* in Ireland. In the account given by Molyneux in 1697, three specimens were disinterred from the same bog within the extent of a single acre, at Dardiston in the county of Meath.

The first specimen discovered in England consisted of a skull and antlers from beneath a peat-moss at Cowthorpe, near North Deighton, in the county of York.

Mr. Parkinson refers the beams of two antlers found in the till at Walton in Essex, on account of their large size, to the great Irish Deer, and I have obtained more satisfactory evidence of the *Megaceros* from the same newer pliocene stratum, by inspection of the collection of fossils belonging to Mr. Brown of Stanway, in which is preserved, not only the large round beam, but the characteristic brow-antler and part of the palm, as far as where it has expanded to a breadth of 10 inches. The length of the brow-antler is $5\frac{1}{2}$ inches, but its extremity is broken off.

Mr. Brown has obtained from the same freshwater formation on the Essex coast, the entire lower jaw of the *Megaceros*.

The base of an antler as large as that of the *Megaceros* has been dredged

* Griffith's Translation of Cuvier, vol. iv. p. 87; vol. v. p. 306.

up from the oyster-bed at Happisburgh, already referred to as famous for the numerous teeth of the Mammoth which it has yielded.

Remains of the *Megaceros* found $8\frac{1}{2}$ feet below the surface of a peat-bog at Hilgay, Norfolk, are preserved in the collection of Mr. Flower, of Hunter-street, London. Antlers of the *Megaceros* have been disinterred from the marl or gravel beneath peat-bogs in Lancashire.

The formerly unique skeleton of the *Megaceros* in the Museum of the University of Edinburgh was obtained from a formation in the Isle of Man, which Mr. E. Forbes, Prof. of Botany in King's College, London, informs me is a white marl, with freshwater shells found in detached masses, occupying hollows in the red marl, which, by the proportion of marine shells of the species found in the neighbouring seas, is referable to the newer pliocene period. The cervine fossils have never been met with in the marine or red marls in the Isle of Man, but only in the white marls occupying the freshwater basins of the red marl; and from the position of the beds containing the remains of the *Megaceros*, Prof. Forbes concludes that this gigantic species must have existed posterior to the elevation of the newer pliocene marl, which is probably continuous with the same formation in Lancashire and at the mouth of the Clyde, forming a great plain, extending from Scotland to Cheshire, and now for the most part covered by the sea.

Fragments of the huge antlers and other remains of the *Megaceros* have been discovered in some of the ossiferous caverns in England. A characteristic specimen, now in the British Museum, was obtained by Mr. M'Enery from Kent's Hole; it consists of part of the upper jaw with both series of molar teeth; it precisely corresponds with the same parts in the skull of a *Megaceros* from Ireland. Since, however, other large Ruminants have been introduced into the same cavern, I have compared it with the nearest analogues from that order. The molar teeth and intervening palate are broader transversely in the fossil than in the Ox; the molars differ from those of the Aurochs in the small cusp between the two internal crescents; the posterior palatine foramina, which in the Ox are opposite the interspace of the penultimate and last grinders, and which in the Elk are advanced to opposite the antepenultimate molars, are, in the fossil, opposite the middle of the penultimate molars, as in the *Megaceros*.

Thus the evidence of the former existence of the gigantic extinct Deer, *Megaceros Hibernicus*, though less striking and abundant in England than in Ireland, is complete, and of greater value, inasmuch as it establishes the contemporaneity of that species with the Mammoth, Rhinoceroses, and other extinct Mammalia of the period of the formation of the newest tertiary freshwater fossiliferous strata.

Conclusion.

Collections of Mammalian bones from turbaries and peat-bogs, from the beds of rivers and from gravel-pits, with parts of the human skeleton, and other evidences of their deposition within the human period, have not unfrequently been submitted to my inspection. Such collections have never presented any evidence of an extinct species, and have for the most part included unequivocal remains of the domesticated quadrupeds. Thus a collection of Mammalian bones, transmitted to me by Dr. Richardson of Haslar, from a gravel-pit in Lincolnshire, contained the remains of a Dog, Cat, Hog, Horse, Ass, Ox, and Sheep. A similar collection obtained from the banks of the river Avon, in sinking the foundations of a bridge over the river near the town of Chippenham, included bones of the Dog, Horse, Hog, Ox, Red Deer, and Goat or Sheep.

Such remains have undergone but little change, are not adhesive or absorbent from the loss of the animal matter, nor weighty from the addition of mineral or metallic salts; and are here adduced, though not strictly belonging

to a record of fossil Mammalia, to exemplify how readily and exclusively the remains of existing species and varieties of Mammalia, of which so few present themselves in the formations anterior to the human period, are detected when they occur in places of later date.

In fens, turbaries and bogs, the remains of Mammalia indicate recent species, but such, for the most part, as have either existed but are now extirpated in Great Britain, as the Wolf, the Bear, and the Beaver; or which still remain in a wild or domesticated state, as the Fox, the Wild Boar, the primitive short-horned Ox (*Bos longifrons*), the Goat, &c.

In the freshwater marls beneath the bogs, and in similar deposits overlying newer pliocene strata with marine shells, we first meet with extinct species, as the *Cervus Megaceros*, *Urus priscus*, &c., belonging to genera which continue to be represented in Great Britain or in Europe by existing species. The unstratified drift or 'till,' so widely dispersed over this island, yields evidence of extinct species belonging to genera still represented, but not in Britain or in Europe, by living species; the *Elephas primigenius*, *Rhinoceros tichorhinus*, *Hippopotamus major*, *Hyæna spelæa*, are familiar examples.

Most of the testaceous Mollusks, which lived contemporaneously with these extinct quadrupeds in England, belong to species which still exist in this island; indicating, as Mr. Lyell* has justly observed, that the climate was not so hot as that of the latitudes to which the Elephant, Rhinoceros and Hippopotamus are now confined.

The freshwater deposits, as those discovered by Mr. Brown at Clacton in Essex, and described by Mr. Lyell at Mundesley and other parts of the Norwich coast, which, from the occurrence of a few species of shells distinct from any at present known in a living state, are referable to the newest tertiary epoch, contain similar evidence of extinct species of Mammalia; some belonging to genera, as *Canis*, *Ursus*, *Felis*, *Putorius*, *Arvicola*, *Castor*, *Equus*, *Bos*, *Cervus*, still represented by European species, and others to genera, as *Elephas*, *Rhinoceros*, *Hippopotamus*, *Hyæna*, now confined to the warmer parts of Asia and Africa.

The same association of Mammalian fossils in the ossiferous caverns of Great Britain, indicates the period of their introduction to have corresponded with that of the deposition of the remains above alluded to in the newer pliocene strata; in some of the latter, however, as in the lacustrine ligniferous beds near Bacton, on the Norfolk coast, we obtain evidence of extinct subgenera of Insectivora and Rodentia, as the *Palæospalax* and *Trogontherium*.

When we descend to the older pliocene tertiary formations, as the fluvio-marine crag at Whitlingham, Postwick, Thorpe, and Bramerton in Norfolk, remains of the *Mastodon* occur.

The Eocene tertiary formations reveal more numerous extinct Mammalian genera, and more remote than the *Mastodon* from existing types; while the indications of existing genera, as of the *Macacus*, and perhaps *Didelphys*, are very scanty, and such as one might have least expected to meet with in the latitudes of England.

The constancy of the association of particular organic remains with particular geological strata, is most strikingly illustrated by discovering in the Eocene deposits of England the same peculiar extinct Mammalia which had been determined by Cuvier's masterly investigations of the fossil remains from the corresponding formations on the Continent. In addition to *Lophiodon*, *Palæotherium*, *Anoplotherium*, *Dichobunes*, and *Chœropotamus*, only one other extinct *genus* has been discovered in the Eocene strata of Britain, viz. the *Hyracotherium*, and the nearest affinities of this little Pachyderm are to the *Chœropotamus* of the same epoch.

* Principles of Geology, ed. 1835, vol. i. p. 142.

Thus the existing species and genera of mammiferous animals gradually recede from our view, and new and strange forms appear, as we successively reinstate and bring before the mind's eye the animated beings of the more remote tertiary periods of the earth's history.

The most extraordinary feature in the Palæontology of this island is the proof of the high antiquity of the Mammalian class which has been derived from the oolitic slate at Stonesfield in Oxfordshire. If the existing generic types are almost lost when we reach in a retrospective survey the oldest tertiary periods, we might anticipate that the Mammalia of the oolitic epoch would differ as much from the peculiarly eocene generic forms as these do from those which now exist, and we accordingly find such an anticipation fully borne out by the ascertained characters of the *Amphitherium* and *Phascolotherium*— the most ancient Mammalian inhabitants of this planet.